Report of The Special Committee on Reorganisation and Development of Polytechnic Education in India 1970-71

Parts I & II

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CHAPTER I

1.0. INTRODUCTION

1.1. Background

1.11. In recent years, there has been serious criticism [illegible] system of polytechnic education by educationists, representatives of industry, professional bodies and employers. The common points of criticism are as follows:

(a) The diploma courses in our polytechnics are mostly theoretical with very little practical bias.

(b) The diploma courses are a poor imitation of the degree courses, and as such do not really serve the purpose of training middle level technical personnel.

(c) The diploma courses, as conducted at present are in the broad fields of civil engineering, mechanical engineering, electrical engineering, metallurgy, etc. No attempt has been made towards specialisation in any one particular branch of a subject field in which specialist technicians are required.

1.12. These and several other factors have been causing concern to persons responsible for the development of technical education. Their anxieties have found expression, on several occasions, in the meetings of the All India Council for Technical Education, the Institution of Engineers (India), the All India Manufacturers' Organisation, the Indian Engineering Association, the Indian Society for Technical Education and other organisations.

1.13. The second conference of the State Directors of Technical Education held on the 14th and 15th June, 1969 at Delhi has also stressed the need for the reorganisation of polytechnic education.

1.14. It was in this context that the initiative for focussing attention on the reorganisation of the system of Polytechnic Education came from Prof. V. K. R. V. Rao, Union Minister for Education and Youth Services. Presiding over the 20th meeting of the All India Council for Technical Education held on the 23rd September, 1969, Prof. Rao expressed concern over the state of polytechnic education and suggested that the present stage of consolidation of technical education is opportune for reorganising the polytechnic courses. He also outlined the following general guidelines for consideration:

(a) A system of polytechnic education that articulates the joint and co-operative effort of technical institutes and industry should be developed. The primary need is for a purposeful system of industrial apprenticeship that industry accepts as its responsibility. The technical institutes, on the other hand, should consider apprenticeship as an integral part of the total process of polytechnic education.

(b) Polytechnics and industry which are located near each other should co-operate in organising and conducting sandwich courses for training the correct type of technicians that industry requires. Sandwich courses should become ultimately a general pattern for all polytechnics which are located close to industry.

(c) It is only through better faculty development and through better selection procedures for admission of students that the prevalent ineffectiveness of the teaching and learning in the polytechnics can be corrected.

(d) Polytechnics, in close co-operation with industry, should carry out an analysis of the functions, fields of activity and typical job positions available, identify various technician specialities and reorganise their curricula to suit them. In doing so, the polytechnics should bear in mind the pattern of employment in major sectors of engineering activity, the need for the mobility of technicians—both vertical and horizontal, and the immediate and future employment opportunities available to them. Each polytechnic should, in consultation with the employing authorities concerned, ensure that there is an adequate demand for the specialist technicians to be trained. Training in each speciality should be a judicious combination of theory and practical experience in the field.

(e) The curiculum should aim to give a broad-based education in the major fields of engineering. Training in a particular speciality should be built on this broad base. This is necessary to ensure that, if the diploma holder cannot get a suitable job in his speciality, he would not become unemployable as a technician in another relevant field; his horizontal mobility should not become difficult.

1.15. Prof. V. K. R. V. Rao suggested that a high-power Committee consisting of experts in technical education and industry should examine the entire system of polytechnic education. The Committee should not only examine the present inadequacies in the system and suggested measures for improvement, but also prepare a blue-print to reorganise all aspects of polytechnic education during the next ten years. He also suggested that experts from Britain, Germany, USSR, USA and other countries, where similar problems have been dealt with effectively, should be invited to advise and assist the Committee.

1.2. Setting up of the Committee

1.21. On the advice of the All India Council for Technical Education, the Government of India constituted the Special Committee for Reorganisation and Development of Polytechnic Education under the Chairmanship of Prof. G. R. Damodaran.

1.22. The composition of the Special Committee is as follows:

Chairman

Prof. G. R. Damodaran, PSG College of Technology, Coimbatore-4.

Members

Prof. S. K. Das Principal, Technical Teachers' Training Institute, 7, Mourbhanj Road, Calcutta-23.

Dr. S. M. Dasgupta, Director, Govindram Seksaria Institute of Technology and Science, Indore-3.

Shri K. C. Lall, Principal, YMCA Institute of Engineering (Faridabad), Zakir Nagar, Mathura Road, Faridabad.

Shri A. L. Narayan, Principal, Government Polytechnic, Hyderabad.

Dr. Pranlal Patel, Messrs, Malleable Iron and Steel Castings Co. Pvt. Ltd., and President, All India, Manufacturers' Organisation, Tulsi Pipe Road, Lower Parel, Bombay-13.

Shri Y. Saran, Principal, S. V. Polytechnic Bhopal. (at present, Principal, of TTTI, Bhopal).

Prof. B. Sengupto, Lat-Bagan, P.O. Shahganj, Dist. Hooghly.

Shri S. G. Somani, Hon. General Secretary, All India Manufacturers' Organisation, Bombay.

Member-Secretaries

Shri Biman Sen, Deputy Educational Adviser (T) Ministry of Education and Youth Services, New Delhi.

Shri D. V. Narasimham, Deputy Educational Adviser (T) Ministry of Education and Youth Services, New Delhi.

1.23. The Committee co-opted the following members:

Shri K. R. Sivaramakrishnan, Institute of Applied Manpower Research, Indraprastha Estate, New Delhi.

Col. S. G. Pendse, Director of Training and Central Apprenticeship Adviser, Directorate General of Employment and Training, Shram Shakti Bhawan, Rafi Marg, New Delhi.

Shri M. V. V. Raman, Director (Industrial Engineering), National Productivity Council, 38, Golf Links, New Delhi.

Prof. H. C. Guha, (Representative of Institution of Engineers (India), 77-A, Ibrahimpur Road, Jadavpur, Calcutta-32.

1.24. The following foreign experts were associated with the work of the Committee:

Prof. Ross Henninger	USA
Mr. E. Houghton	Bretain
Prof. W. D. Kurz	West Germany
Dean Minoru Shimosaka	Japan

1.25. The terms of reference of the Committee were as follows:

(a) to examine the whole system of polytechnic education *vis-a-vis* the needs of industry for middle level technicians and to prepare a ten year plan for its reorganisation and development;

(b) to recommend measures for improving the practical content of diploma courses through co-operation between polytechnics and industry with particular reference to sandwich courses, apprenticeship training and diversification of subject fields; and

(c) to report on all other aspects of polytechnic education.

1.3. Sittings of the Committee

1.31. The first meeting of the Committee was held at New Delhi on 4th April, 1970. It was inaugurated by Prof. V. K. R. V. Rao, Union Minister for Education and Youth Services, who bro indicated the guide-lines for the work of the C mittee. (Prof. Rao's address is given in Appe No. I).

1.32. After a general discussion on the terms of reference the Committee decided to adopt the following strategy of action:

(a) To undertake a sample survey of industry in order to find out the types of technicians required. This survey should cover a cross-section of industry embracing the heavy, medium and small scale industries,

(b) To make a thorough analysis of the present system of polytechnic education in order to find out the lacunae and deficiencies *vis-a-vis* job requirements.

(c) To examine how far diversification at the technician level is possible keeping in view the need for mobility of technicians—both horizontal and vertical.

(d) To examine the fields in which sandwich courses could be successfully started with indications of the structure of the courses, duration etc.

(e) To examine how best the practical training be made industry-oriented and the type of training which the students should get and its corelation with the teaching.

(f) To examine the aspects of faculty development ,the types of training and retraining programmes for teachers and the type of industrial training required to keep them up-to-date.

(g) To analyse the present evaluation system in order to modify and make it purposeful.

(h) To consider ways and means of achieving the maximum involvement of industry in the training of technician-students and teachers.

1.33. The Committee, at its first meeting, set up two sub-committees to make preliminary studies.

(a) The sub-committee to examine all aspects of the present Polytechnic Education and to formulate future educational programmes, was constituted as follows:

Prof. B. Sengupto (Convenor)

Shri A. L. Narayan

Shri S. K. Das

Shri Y. Saran

Shri N. Gnanasambandham

Prof. S. M. Dasgupta

(b) The sub-committee to prepare a questionnaire and conduct a sample survey of industry was constituted as follows:

Dr. Pranlal Patel (Convenor)

Shri K. R. Sivaramakrishnan

Shri S. G. Somani

Shri Y. Saran

Shri K. C. Lall

At the second meeting held at Bangalore, the Committee authorised the Chairman to conduct an independent, brief and quick survey of the utilisation of technician manpower in industry.

1.34. Subsequently the Committee met at Bombay, Calcutta and New Delhi before its concluding session at New Delhi on the 26th, 27th and 28th February, 1971.

1.35. During the course of the meetings held in various regions, the Committee met the Directors of Technical Education of various States, representatives of the Institution of Engineers (India), the All India Manufacturers Organisation, the Indian Engineering Association, Chamber of Commerce and other organisations in order to ascertain their views.

1.36. In Bombay, the Committee met the members of the Special Committee appointed by the Government of Maharashtra for the reorganisation of Polytechnic Education in that State.

The list of persons interviewed by the Chairman and the Committee is given in Appendix No. 2.

1.37. The Committee also sought and obtained the views of principals and teachers of polytechnics in the country.

1.38. At the fourth meeting of the Committee held on the 17th and 18th October, 1970, at Calcutta, a Drafting Committee was appointed with the following members:

Prof. G. R. Damodaran (Convenor)

Prof. B. Sengupto

Col. S. G. Pendse

Dr. Pranlal Patel

Shri K. R. Sivaramakrishnan

Shri Biman Sen.

1.39. Based on their study of selected polytechnics in different States, the foreign consultants submitted individual reports to the Committee. The reports of the consultants are given in Appendix No. 3. The Committee considered these reports at its fifth meeting held at New Delhi.

1.310. During the course of its work, the Committee also appointed the following Working Groups:

(a) *Working Group to prepare the draft framework of a Ten Year Plan.*

Prof. G. R. Damodaran (Convenor)

Shri K. R. Sivaramakrishnan

Dr. Prem Bhatt

Shri P. Sivalingam.

Shri Biman Sen

(b) *Working Group to examine the ways of organising Practical Training, securing the co-operation of industry and starting of sandwich and diversified courses.*

Prof. G. R. Damodaran (Convenor)

Shri S. G. Somani

Prof. B. Sengupto
Shri M. S. S. Varadan
Shri T. R. Doss
Prof. A. P. Jambulingam
Shri D. V. Narasimham

1.4. **Draft Report**

1.41. The Draft Report prepared by the Drafting Committee was considered at the last sitting of the Committee held at New Delhi between the 26th and 28th February, 1971 and adopted after modifications.

CHAPTER II

2.0. A REVIEW OF THE DEVELOPMENT OF POLYTECHNIC EDUCATION

2.01. Although the history of technician education in our country can be traced back to over 150 years, unfortunately very little growth or development took place prior to Independence. The growth of technical education depends on the socio-economic and industrial conditions of the country and its development is controlled by the needs and requirements of the economy. Therefore, it is not surprising that technical education, particularly technician education, did not make much progress prior to Independence.

2.02. In 1947, the country was faced with the great challenge of rapidly industrializing the predominantly agricultural economy. In order to do so, the country had to build up its technical education system within a short period. Perhaps one of our most remarkable achievements since Independence has been the phenomenal growth of technical education. In 1947, there were about 53 institutions conducting technician courses (diploma courses) with a total admission capacity of about 3,700 students per year; the total out-turn from these institutions was of the order of 1,500 per year. The number of institutions offering technician courses (diploma courses) was progressively raised to 284 by 1966. The total annual intake capacity was increased to about 49,000 and the annual out-turn to about 23,500. Owing to the recession during the period 1965 to 1967, the admission to Polytechnics (from the year 1968) was restricted to about 37,000. However, the actual intake came down to the order of 27,000 and the level of admission has remained more or less the same since then.

2.03. In addition to the 284 Polytechnics, there are about 22 Polytechnics functioning throughout the country catering exclusively for girls. These polytechnics offer a wide range of courses. The annual admission capacity of these institutions is approximately 2,200.

2.04. Three patterns of courses have so far been evolved for technician education: (1) three-year full-time courses, (2) two-year full-time courses, and (3) sandwich courses. About 94 per cent of the polytechnics (excluding the girls' polytechnics) offer the three-year full-time diploma courses.

2.1. Survey and Distribution of Polytechnics.

2.11. The State-wise distribution of polytechnics and the subject-wise distribution of facilities are given in Tables 2.1, 2.2, 2.3, and 2.4 It may be observed that 92 per cent of the student body of the polytechnics (excluding the girls polytechnics) is at present distributed only in the three major fields of engineering, *viz.*, civil, electrical and mechanical

2.12. A State-wise list of polytechnics with their annual admission capacity, out-turn for 1969, subject fields and locations is furnished in Appendix No. 4.

2.2. Existing Organisational Pattern.

2.21. With the phenomenal expansion of all sectors of education since Independence, the administration of education has become complex. During the post-independence period several new dimensions have been added to the functions and responsibilities of Government in policy-making, co-ordination and fulfilment of national targets in education. In this process technical education has received special emphasis.

2.22. The All India Council for Technical Education was constituted in November, 1945 to advise the Government of India on all aspects of technical education. It consists of representatives of the Union and State Governments, Parliament, associations in the fields of business, industry, labour and education, and professional bodies. Though the Council is an advisory body, experience shows that its recommendations have, by and large, been accepted in the past by the Union and State Governments. The four Regional Committees of the Council, each covering a group of States, have their offices at Kanpur, Madras, Bombay and Calcutta and assist the A.I.C.T.E.

2.23. The All India Council for Technical Education has set up eight Boards of Technical Studies in different branches of engineering, technology, management etc., to advise the Council on such matters as the preparation of model courses of studies, and the specification and regulation of standards in the respective subject fields.

2.24. Tehnical education is normally administered by the Education Departments of State Governments. In some cases, however, it is being administered by other departments such as Department of Industries or Public Works Department etc. On the recommendation of the All India Council for Technical Education, each State has set up a State Board of Technical Education. Most of the State Governments have also established separate Directorates for the effective administration of technical education.

2.25. The activities of the polytechnics in each State are coordinated through the concerned State Board of Technical Education within the overall national policies formulated by the All India Council for Technical Education. The Directorate of Technical Education is responsible for the administration and inspection of the polytechnics and provides secretariat assistance to the State Board of Technical Education which conducts the examinations and awards the diplomas.

2.26. At present, about 70 per cent of the polytechnics are run by State Governments and the rest by private agencies or autonomous bodies.

2.27. Perhaps one of the weakest links in the development of technical education at present is the system of evaluation, inspection and feed back. Neither at the national nor at the State levels, is there an adequate machinery for the systematic evaluation of the work and progress of different institutions. In the absence of such a machinery there has been very little feed back of information which is very necessary to make the technical education system more sensitive to the needs.

2.3. Employment and Collaboration with Industry

2.31. The Survey of Industries which has been carried out on behalf of the Committee reveals that only 36 per cent of the positions at the middle level in industry are occupied by diploma holders, 48 per cent being held by persons who have risen from the craftsmen level and about 16 per cent by engineering graduates. It is clear that although there is unemployment among the diploma holders, there is at the same time a tendency in industry to assign a significant proportion of technician positions to persons without formal qualifications but with job experience at the craftsman level. The Survey further reveals that the products of polytechnics do not and cannot straightway fit into job situations in industry, because the education and training which are now being imparted at the polytechnics are not sufficiently industry or practice-oriented.

2.32. The main reason for such an anomalous situation is perhaps the lack of collaboration between industry and the polytechnics. There is a tendency for the polytechnics to grow in isolation.

2.4. Need for Qualitative Improvement

2.41. An analysis of the current unemployment among engineering graduates and diploma holders was recently made by the Institute of Applied Manpower Research. It revealed that out of the 56,700 persons estimated to be unemployed by the end of 1968, as many as over 46,000 were diploma holders. According to the data available from the Employment Exchanges, for every engineering graduate registered as unemployed, there are 5 unemployed diploma holders even though the annual out-turn of graduates and diploma holders is in the proportion of approximately, 1:2.

2.42. One of the factors leading to this increasing unemployment among diploma holders is reported to be the deficiencies of the present polytechnic courses *vis-a-vis* the requirements of industry. The shortcomings of these courses as revealed by the Committee's Survey of Industries are described in Chapter IV. The Committee would like to stress in this context the need to accord a much higher priority in technician education development to the qualitative improvement of courses and consolidation of existing institutions rather than to quantitative expansion.

2.43. It is also relevant here to refer to an assessment, by the Institute of Applied Manpower Research, of the demand for engineers during the Fifth Plan period. Assuming that the economy will grow at an annual rate of 5.5 per cent during the Fourth Plan and 6 per cent during the Fifth Plan, as postulated by the Planning Commission, the overall demand for engineering graduates and diploma holders in 1978-79 is expected to be met with the current levels of admissions in technical institutions. It will also be possible to meet any additional demands of a marginal nature within the overall sanctioned intake capacity in the existing institutions.

2.44. The Committee is therefore of the view, that, at least for the next five years, there would be no need to consider the establishment of new polytechnics. As for the intake capacity of existing polytechnics, the position may be reviewed after three years and any changes necessary may be made so as to meet the actual needs. The resources available in the current Five Year Plans of the States and the Ministry of Education and Youth Services should be devoted to programmes aiming at qualitative improvement of technician education on the lines suggested in this Report.

2.45. At the same time, efforts should be made to prepare realistic estimates of the demand for technicians for the Sixth and subsequent plans, regionwise and by specialities and types of technician functions in industry, commerce, services and public utilities, so that appropriate programmes of educational development could be formulated and included in the Fifth Five Year Plan.

TABLE 2.1

Statewise distribution of polytechnics (excluding Girls' polytechnics) as in the year 1969-70.

S. No.	State	Institutions Conducting 3-Year courses	Institutions conducting 2-Year courses	Institutions conducting sandwich courses
1	Andhra Pradesh . .	18	1	1
2	Assam . . .	6	..	..
3	Bihar	14	..	..
4	Chandigarh . . .	1	..	..
5	Delhi	3	..	..
6	Goa . . .	1	..	..
7	Gujarat . . .	17	..	..
8	Haryana . . .	6	..	1
9	Himachal Pradesh . .	2	..	..
10	Jammu & Kashmir .	2	..	..
11	Kerala . .	16	..	..
12	Madhya Pradesh . .	22	..	..
13	Maharashtra . .	24	2	..
14	Manipur . . .	1	..	..
15	Mysore . . .	27	..	..
16	Orissa . . .	6	..	1
17	Pondicherry . .	1	..	..
18	Punjab . . .	10	..	1
19	Rajasthan . . .	6	..	..
20	Tamil Nadu . . .	27	..	3
21	Tripura . .	1	..	..
22	Uttar Pradesh . .	33	3	..
23	West Bengal . .	23	2	2
	TOTAL . .	267	8	9
	TOTAL . .	284		

NOTE : Government Polytechnic, Hyderabad (A.P.) also offers the two year diploma course.

TABLE 2.2

Subject-wise distribution of capacity together with total intake and out-turn for the year 1969-70

(excluding Girls' Polytechnics)

S. No.	Subject area	Maximum in-take capacity as in 1966	Admission 1969-70	Out 1969-70
1	Civil	15,190	6,402	4,812
2	Mechanical . . .	16,339	9,194	8,905
3	Electrical . . .	13,395	7,460	6,035
4	Electronics/Telecom/ Radio Engg. . .	350	290	223
5	Mining . . .	400	154	95
6	Metallurgy . . .	240	166	86
7	Automobile . . .	497	414	243
8	Textile . . .	493	413	280
9	Leather Technology .	95	112	59
10	Paper and Pulp Technology	50	40	54
11	Printing Technology .	385	409	207
12	Textile Chemistry . .	95	55	49
13	Chemical Operator Chemical Engg. . .	180	220	147
14	Pharmacy & Dressers course . . .	400	478	219
15	Ceramics . . .	64	34	24
16	Sound	61	68	23
17	Refrigeration . .	40	59	35
18	Production Engg. . .	190	6	9*
19	Industrial Engg. . .	..	6	5*
20	Architectural Assistantship	60	68	11
21	Town Planning . .	20	20	18**
22	Industrial Electronics. .	..	10***	..
	TOTAL . .	48,544	26,078	21,539

*1 1/2 years post-diploma course at the PSG Polytechnic, Coimbatore.

**1 year post-diploma course at the Central Polytechnic, Madras.

***Allahabad Polytechnic, 1969.

TABLE 2.3

State-wise distribution of Girls' Polytechnics as in the Year 1969-70

Sl. No.	State	Institutions conducting 3-year course	Institutions conducting 2-year course	Remarks
1	Andhra Pradesh	3	..	Also offers 2-year courses in Commercial Practice and Pharmacy.
2	Assam . .	1	..	Also offers 2-years course in Secretarial Practice
3	Bihar . .	..	..	..
4	Chandigarh .	1	..	Also offers 2-years courses in Commercial Practice, Pharmacy & Library Science.
5	Delhi . .	1	..	Also offers 2-year courses in Secretarial Practice, Library Science & Laboratory Technology.
6	Goa . .	..	..	..
7	Gujarat. .	2	..	Also offers 2-year course in Secretarial Practice.
8	Haryana .	..	1	..
9	Himachal Pradesh . .	..	..	..
10	Jammu and Kashmir .	..	..	..
11	Kerala . .	3	..	Also offers 2 years course in Commercial Practice.
12	Madhya Pradesh . .	1	..	Also offers 2 year courses in Secretarial Practice and Laboratory Technology.
13	Maharashtra .	..	..	..
14	Manipur .	..	..	..
15	Mysore	1	..	Also offers 2-year course in commercial Pratice and Library Science.
16	Orissa . .	..	..	..
17	Pondicherry .	..	..	..
18	Punjab . .	..	..	..
19	Rajasthan .	2	..	Also offers 2-year course in Library Science
20	Tamil Nadu .	3	..	Also offers 2-Year course in Commercial Practice.
21	Tripura .	..	..	..
22	Uttar Pradesh	2	..	Also offers 2-year course in Secretarial practice
23	West Bengal .	1	..	
		21	1	
	TOTAL .	22		

TABLE 2.4

Subject-wise distribution of capacity together with total intake and out-turn for the year 1969-70

(Girls' Polytechnics)

S. No.	Subject Area	Sanctioned Intake (1969-70)	Admission (1969-70)	Out-turn (1969-70)
1.	Electronics . . .	420	329	141
2.	Secretarial Practice .	300	304	123
3.	Interior Decoration and Display . . .	55	36	15
4.	Library Science . .	145	135	86
5.	Medical Laboratory Technology . .	40	29	18
6.	Commercial Arts. .	25	29	18
7.	Architectural Assistantship	180	96	84
8.	Commercial Practice and Stenography . .	300	424	116
9.	Pharmacy . . .	150	162	12
10.	Costume Design . .	245	163	77
11.	Civil/Draughtsmanship .	300	202	67
12.	Catering . . .	30	44	..
	TOTAL	2,190	1,953	757

CHAPTER III

3.0. CONCEPT OF TECHNICIAN AND HIS EDUCATION

3.1. Definition

3.11. In the technical manpower spectrum, while professional engineers and craftsman are easily recognisable, it is more difficult to recognise technicians as a class by themselves, although they occupy a large part of the spectrum. This is so because of the difficulty in drawing clear-cut lines separating certain highly skilled craftsmen and process workers from technicians and the difficulty in distinguishing the well-qualified technicians from some technologists with a similar level of responsibility. As a result, technicians as a class can be identified only by removing professional engineers and craftsmen from the spectrum. There is, however, no doubt that the duties and functions performed by technicians are recognisable.

3.12. The I.L.O. defines a "technician" as a worker who prepares working plans and other technical drawings from suggested sketches or notes for engineering, manufacturing or other purposes; performs technical tasks usually under the direction and supervision of professionally qualified specialists in engineering.

3.13. At the 12th session of the General Conference of the UNESCO held in 1962 the member States adopted the following definition:

> "The term "technician" applies to persons working in occupations requiring a knowledge of technology and related sciences between that of a skilled worker and that of an engineer or technologist; occupations at technicians level may call for inspection and maintenance, detailed development plans, supervision of production work, detail construction. Collaboration with the engineer is an essential part of the work of the technician".

3.14. The Huddersfield Conference on the Education and Training of Technicians held in 1966 identified technicians as being those people employed in the broad spectrum of occupations lying between the craftsmen on the one hand and the professional (or technologist) on the other.

3.15. It may, however, be stated that a technician working in fields such as sales, servicing, routine, maintenance, estimating etc., may need very little guidance or advice from a professional. In such cases he will mostly be working independently except for a nominal professional supervision as a matter of administrative hierarchy. In some situations the technician may be called upon to supervise the work of craftsmen, operators or junior technicians.

So far as the supervision of craftsmen is concerned there is a tendency in industry to leave such supervision to persons promoted from the ranks of skilled craftsmen if the work does not require complex technical knowledge. It has, however, been generally accepted that a technician's job is not an extension of that of a craftsman or an operator. Technicians and professionals are complementary to each other.

3.2. Functions

3.21. The occupation [illegible] chnician may broadly involve one or n [illegible] llowing functions:

(i) Erecting and commissioning of engineering structures, equipment, etc.
(ii) Engineering drawing and detailing;
(ii) Maintenance and repair of engineering plant and machinery;
(iv) Assisting engineering in design and development;
(v) Assisting engineers and scientists in research and development activity;
(vi) Inspection testing;
(vii) Estimating;
(viii) Sales and after-Sales Service.
(ix) Servicing;
(x) Contracting;
(xi) Production and Control;
(xii) Work Study.

3.22. The above functions are related to the engineering industries. While the use of the term technician in business, commerce and other fields is relatively new, there are clearly several occupations which are comparable to those of technicians in the engineering fields. Such occupations include personal secretaries, accountants, auditors, data processing personnel and certain other junior executives.

3.3. Definition and Interpretation Adopted by the Committee.

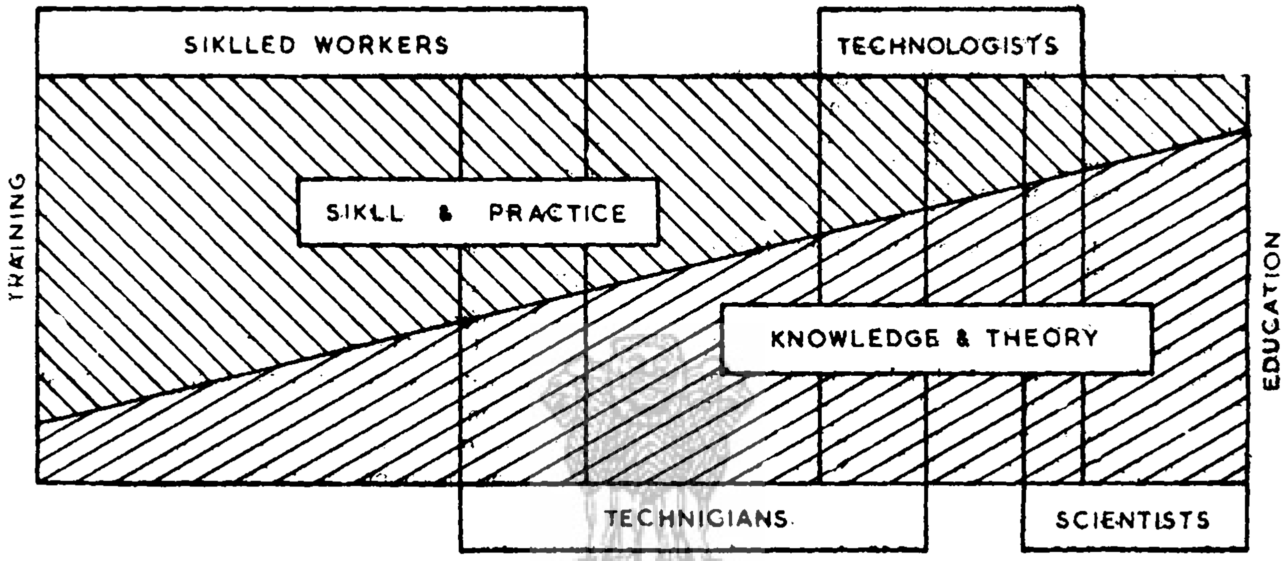
3.31. After a careful consideration of the duties and functions of technicians, the Committee has adopted the following broad definition and interpretation of the term "technician":

> "A technical employee, whatever his designation, who occupies a middle level position between the craftsman and the technologist; whose work requires the application of technical knowledge higher than that of a skilled

> worker but below that of a technologist; whose work moreover requires a proficiency in skills higher than that of a technologist but lower than that of a skilled worker."

The Committee uses the terms "technical" and "technology" in the broadest sense without confining them to denote only the specific disciplines of engineering.

3.32. The following diagram illustrates the two major dimensions which may be used to distinguish skilled workers, technicians, technologists and scientists. For the purpose of this report, the Committee has restricted the areas of technicians to the extent to which technical personnel can be trained effectively through full-time or part-time courses etc. to occupy middle level positions in the technical manpower spectrum as indicated in the schemetic diagram given below:



▧	Skill in techniques based on the knowledge of principles, sufficient to judge the most appropriate technique to adopt or to adapt where necessary.
▨	Thorough knowledge of basic principles as found, for example, in the sciences and their application and/or adaptation in novel or out-of-the common situations.

3.4. Education and Training

3.41. The main objective of the technician education programmes of polytechnics is to give the technician student a sound broad-based knowledge of a chosen field. The education needs to be supplemented with actual practical experience in industry or business and commerce. It is therefore necessary that the programmes of technician education and training should be properly drawn up in an integrated manner with the cooperation of industry. Whereas educational programmes should take care of the present and future needs, training programmes should condition the technician to meet the immediate needs

3.42. Technician jobs involved a level of scientific and technical knowledge higher than that needed by an operator of craftsman, but lower than that of a technologist, engineer or scientist. A technician's education and training should enable him to exercise technical judgment; this judgment is based on an intelligent application of the general principles underlying the technician's work as compared with the reliance upon accumulated skill and experience which is characteristic of the craftsman. Whereas the term 'craftsman' applies to a fairly easily defined and generally recognized degree of skill, the term 'technician' applies to a broad band of abilities ranging from jobs which are only slightly more technical than those of craftsman, right up to others where high-grade technicians are rubbing shoulders with technologists and scientists.

3.43. The special characteristics of technicians' work determine the nature of their education and training. First and foremost, technicians need to have a mastery of those techniques which are directly relevant to their immediate employment. Proficiency in these techniques requires an understanding of the sciences and mathematics on which they are based. This understanding need not be so profound as that of the professional scientist, but should be sufficiently firm to permit its further extension as new applications of the relevant sciences and technology are introduced and also as the technician himself encounters situations which present new requirements for specialisation.

3.44. Most technicians also find themselves concerned technically with the work of others at craft or operative level. They must, therefore, be aware of its nature and problems. This awareness is preferably acquired through the medium of a broad basic training and planned experience which is specifically designed to give direct acquaintance with the work in question.

3.45. Technicians in all fields should also be able to communicate with their colleagues at senior and junior levels, for example, in making reports, issuing and conveying instructions and so on. Therefore, they need fluency in the use of the written and spoken word and this can best be built on the basis of a sound general education.

3.46. The relative extent of the technician's requirement for manual skills as opposed to technical knowledge will depend very largely on the field in which he is employed; in design, for example, it will be minimal, in servicing it may be high.

3.47. During their careers technicians will be required to guide and supervise the work of skilled work people and craftsmen. In due course they may also be expected to rise to positions of responsibility in industry, commerce and society. Some technicians may set up their own industrial or business concerns. Technician education should not lose sight of these aspects of the future life of technicians. Through their courses, educational approach and extracurricular activities, polytechnics should attempt to develop the right type of motivation, the correct attitude towards dignity of labour, a practical way of thinking and a sense of discipline, team work and social responsibility. The confidence and competence needed for self-employment should also be developed.

3.48. Our country is facing the problem of adapting itself to an ever-increasing rate of technological change and scientific progress: if the technician is to play his proper part in the solution of this problem, he must be adaptable and needs to have an appreciation of the social and economic environment beyond the narrow confines of his immediate discipline. This need for flexibility and a wider outlook calls for broad-based courses which include liberal or humanistic studies and the provision of adequate co-curricular, extra curricular and recreational facilities.

3.49. Entry into a technician occupation requires not only an understanding of the scientific principles behind particular technician functions but also a mastery of the techniques and the skills, procedures and processes which are a part of these techniques. Application of these techniques implies a careful selection of the tools, equipment and skills and their judicious use to production objectives. Polytechnics can offer only a part of the training needed to impart these competencies because of the limitations of their workshop facilities. They may include in their programme the training in basic manual and machine skills. The rest of the above practical competencies can only be acquired by industrial or field training. Training to achieve an acceptable level of practical competency is thus an integral part of the education of technicians and the success of technician education programmes will depend on the degree to which the integration of polytechnic courses with relevant field/industrial training is achieved and consequently on the degree to which collaboration between polytechnics on the one hand and industry and commerce on the other is established. The Committee recognises the supreme importance of associating industry and commerce—the employers—with the planning and implementation of technician education and training programmes. From the initial forecasts of technician manpower requirements through the analysis of job content to the preparation of course syllabuses, and the final assessment of the competence of the technicians, there is an urgent need to ensure the closest possible cooperation of employers. The problems of providing proper education and training for technicians are the concern of a partnership between government, employers and the educational system; each has its responsibilities and each must collaborate with the others in a combined effort if the right solutions are to be found and applied.

CHAPTER IV

4.0. SURVEY OF INDUSTRY

4.01. To consider the nature and direction of the reorganisation of polytechnic education to meet the real needs of industry for middle level technicians, it is necessary, among other things, to ascertain the job positions available in industry for diploma holders, the qualities and skills expected of them, the pattern of in-service development and promotion prospects and the need and nature of re-training and updating courses. Moreover, a study of the views and suggestions of Industry on the present diploma courses, and an assessment of the in-plant facilities which could be made available by industry, would be useful in planning for the education and training of technicians on proper lines.

4.02. The Chairman of the Committee therefore undertook a detailed survey of selected industrial establishments covering a representative sample of the engineering and process industries and the public utilities and services. The Report of the Survey is given in Appendix No. 5. A pilot study was also made by the Technical Teacher Training Institute, Calcutta, aiming at an anlysis of technician jobs in two selected engineering establishments. In this chapter, a brief resume is given of the findings of these studies with special reference to the qualitative needs of technician education and training.

4.1. **Pattern of Employment.**

4.11. Technician positions in industry are occupied by engineering graduates, diploma holders and engineering practicals* i.e., those who do not have formal technical education qualifications but perform the functions on the basis of their job experience. According to the Survey, the proportion of these groups is as shown in Table 4.1.

TABLE 4.1

Technician positions by educational qualifications.

Industry group	Proportion (in percentage)			
	Engg. Graduates	Diploma Holders	Engineering* Practicals	Total
1	2	3	4	5
Mechanical Engg. Industry	11	41	48	100
Electrical Engg. Industry .	16	38	46	100
Metallurgical (including Mining) Industry. . .	9	37	54	100
Processing Industry . .	23	24	53	100
Others	26	29	45	100
Overall proportion . .	16	36	48	100

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*In the Report of the Survey of Industries, the phrase persons with job experience only" is used in place of the term engineering practicals".

4.12. There are wide variations in the pattern of utilisation of diploma holders as technicians within these industry groups, the proportion ranging from 24 per cent in the processing industry to over 60 per cent in the automobile, ship-building, machine tool, and paper industries.

4.13. A sizeable proportion of skilled craftsmen get promoted to technician positions after they gain experience on the shop floor. Sufficient attention has not been given to this group of technicians in the present system of polytechnic education. Polytechnics have the necessary facilities to offer a variety of short-term and part-time educational courses to supplement the technical skills of these craftsmen, especially to equip them for their role in planning, supervising and managing men and materials.

4.14. In terms of functions, technicians are distributed into the three fields of (a) design and production, (b) laboratory testing and analysis and (c) sales, stores and costing, as shown in Table 4.2.

TABLE 4.2

Functional distribution of technicians.

Industry group	Proportion (in percentage)			
	Design & Production	Laboratory testing & analysis	Sales Stores etc.	Total
	2		4	5
Mechanical Engineering Industry . . .	74	19	7	100
Electrical Engineering Industry . . .	65	19	16	100
Metallurgical (including Mining) Industry . .	N.A.	N.A.	N.A.	N.A.
Processing Industry . .	68	24	8	100
Others	N.A.	N.A.	N.A.	N.A.
TOTAL . .	69	20	11	100

N.A.: Not available.

The concentration of technicians in the design and production field, especially in the engineering industry, is noteworthy. It is also observed that in the process industries, such as petrochemicals and electronics, a substantial number of technicians, about 30 percent, are engaged in process control and laboratory work. In industries like electrical machinery manufacture and textile machiney manufacture, there is a growing demand for technicians for sales and services.

4.2. Requirement of Technical Knowledge and Skills

4.21. Irrespective of the nature of processes or organisations, the main qualities expected of diploma holders for filling up technician positions in industry are: (a) knowledge of basic technology in the chosen field, (b) knowledge of engineering practice in industry, (c) ability to apply technical knowledge to practical situations, and (d) personnel qualities and leadership ability. Industries also stress the importance of communication skills for their technicians.

4.22. In relation to the qualities identified above, the present diploma courses need reconsideration particularly in the matter of practical orientation. 96 percent of the respondents to the Survey stated that the present diploma holders do not possess the skills necessary performing technician duties. It was noted that the technical knowledge of diploma holders in particular specialities is not of sufficient depth.

4.23. Industry is generally in favour of specialised instruction and training in a number of diversified fields in place of the present generalised courses in broad fields; a suitably broad-based study is however felt to be necessary before any specialised study is undertaken.

4.3. Organisation of Technician Education

4.31. An attempt was made through the Survey to ascertain the views of Industry on the possibility of organising diploma courses on a sandwich pattern. Sixty six percent of the respondents favoured sandwich courses with specialisation. The Engineering Industry in general supports sandwich courses whereever such courses are feasible this includes eightyone per cent of the respondents from the heavy engineering industry, seventy seven per cent from the electrical industry and seventy per cent from the electronics industry.

4.32. In regard to process industries, a majority of the respondents were in favour of specialisation without sandwiching; they, however, stressed the need for training the industry after the institutional programme.

4.33. It was also stated by most of the respondents that specialisation should be considered according to the needs of different industries. A view was expressed on behalf of some units in the petro-chemical industry and in the electronics industry that sponsorship of students by industry to technician courses would be very desirable.

4.34. A close coordination between industry and education is considered essential in the process of technician education and training. This will be necessary, among other things, for the periodic revision of curricula and development of new courses whereever necessary, for providing facilities to teachers of polytechnics to gain industrial experience, for sponsoring candidates to sandwich courses and for conducting such courses. Most of the respondents to the Survey expressed their willingness to cooperate with polytechnics in all these areas.

4.4. Training of Diploma Students in Industry

4.41. Consistent with the view that training in industry is an essential component of the education of technicians, many industries have offered facilities for organising such training, subject to certain conditions of financial and organisational commitments. In this context, it is emphasised by Industry that such training should be properly planned and effectively supervised.

4.5. Training of Polytechnic Teachers in Industry

4.51. Respondents from industry emphasise that the teachers in polytechnics should be uptodate in their knowledge of the practices in industry in order to make polytechnic education application-oriented and relevant to the needs of industry. Nearly 80 per cent of the respondents are willing to offer the necessary facilities for the industrial training of teachers subject to certain conditions. These conditions mainly concern (a) the cost to be incurred for the training and (b) the safeguards necessary to maintain technical secrets relating to their products, processes and techniques.

4.52. Various suggestions have been made about the duration of the industrial training of teachers. The durations proposed vary from one month to 5 years at a time, the longer duration being generally meant for new entrants to the teaching profession. In the opinion of Industry, such training should be made an essential qualification for recruitment as teachers. There should also be provision for further training of shorter duration from time to time during the tenure of work of teachers.

4.6. Retraining

4.61. The Survey reveals an increasing appreciation by Industry of the need for refresher courses and retraining programmes for technicians working in industry. The factors supporting this need are: (a) technological developments and continuing changes in processes and products; (b) occupational mobility of technicians; (c) the need to update knowledge for improved performance; (d) the specialised requirements of certain industries; and (e) continuing improvements in management techniques.

4.62. Several industries have suggested special short-term courses for technicians in industrial and production engineering and in the modern concepts and techniques in their subject fields. Some of the subjects indicated in this connection are: (a) operations research; (b) instrumentation; (c) tool design and engineering; (d) production planning; (e) standardization; (f) materials planning and control; (g) quality control; and (h) cost control.

4.63. Some of the above subjects, like quality control and production control, are in the nature of basic requirements for any technician course and should be included in the pre-employment education offered in polytechnics. Wherever Industry identifies specific areas of retraining, polytechnics should devise suitable short-term courses jointly with the industry concerned and conduct such courses either in polytechnics and/or in industry.

4.7 Job Analysis

4.71. The sample job analysis made by the Techniciands ETAOIN SHRLUD CMFWYP ETAOINT nical Teacher Training Institute, Calcutta, primarily as a pilot study, broadly supports the findings of the Survey particularly on the need (a) to specialise by means of diversified technician courses, (b) to develop supervisory and managerial skills, (c) to improve the technician's ability to plan, organise and control shop-floor activities, (d) to develop the ability to communicate effectively with engineers and craftsmen, (e) to ensure a sound knowledge of engineering principles and sciences along with skill in the application of such knowledge to practical problems, and (f) to consider the process of technician education as a co-opera effort of polytehnics and industry.

4.72. An overall review of the duties/tasks, knowledge, skills and responsibilities of technicians indicates that polytechnics and industry have complementary roles to assume in the education and training of technicians. Whereas certain knowledge and skills basic to all technicians (irrespective of the industries in which they are likely to find employment) could be imparted institutionally, there are certain other skills and knowledge that can be imparted only through in-plant/apprenticeship training in industry. These vary from industry to industry. Further, the education and training of technicians, like that of all other professional persons, is a continuing process and does not cease with the first employment; so much so, that the appropriate forms of refresher and retraining courses should be formulated keeping in view the changing requirements of jobs for skills and knowledge and the ability and needs of the individual technician. In order to identify these needs, as well as to aid the diversification of educational programmes in polytechnics, it is necessary to undertake job analysis surveys of a wide representative cross-section of industry, commerce and the public utilities.

4.8. The Committee has carefully considered these suggestions. It has also taken into account the suggestions made by industrial associations and professional organisations like the Institution of Engineers (India). In the recommendations which follow, these views and suggestions have been cooordinated with the factual data on the education and employment of diploma holders so that the present system may be reorganised on proper lines.

CHAPTER V

5.0. REORGANISATION OF POLYTECHNIC EDUCATION

5.01. The duties and functions of technicians and the corresponding educational and training requirements have been outlined in Chapter III. The deficiencies of the present system of technician education and training and the desirable improvements pointed out by industry have been summarised in Chapter IV. This chapter examines the reorganisation of the educational programme and the organisational set-up in the light of the several views and suggestions presented to the Committee.

5.1. Need and Nature of the Reorganisation of Courses

5.11. Need for Diversification of Diploma Courses.

(a) Industry has drawn attention to the inadequacy of the technical knowledge of present diploma holders. Particularly their lack of depth of knowledge in different technician specialities has come under criticism.

(b) This criticism is but quite natural if one looks at the bewildering variety of specialised technological techniques, operations, procedures, and equipments which characterise the present-day industrial activities. New methods, materials and processes are emerging rapidly. Side by side, new techniques of production management, as in production control and industrial engineering, are developing. Commerce and business are also making an increasing use of scientific and specialised methods in organisation, sales and management. Correspondingly, there has been considerable development in technician functions and specialities. Underlying these specialities there is such a great deal of specialised theory and practice that a general course in a major branch of engineering can only superficially cover all these specialities. It may, therefore, appear desirable to favour a narrow specialisation of the courses to facilitate a study of each speciality in depth. However, there are weighty reasons against such narrow specialisation, the important among them being:

(i) In the Indian context, narrow specialisation will severely restrict the employment opportunities and mobility of technicians.

(ii) Narrow specialisation may restrict future occupational advancement for want of higher level positions in many of the specialised fields.

(iii) In the absence of broad-based technical knowledge, the scope for further study and adaptability to technological changes will be limited.

(c) Bearing these considerations in mind, the Committee feels that, at present, narrow specialisation is undesirable at the first diploma level. The diploma courses should, wherever necessary, be diversified to provide for a range of broad specialisations within the major branches of study. These broad specialisations should, moreover, be built on the broad based study of the basic principles of engineering, technology or other fields and the applied and basic sciences and mathematics common to the entire branch.

5.12. Need for Sandwich Courses

(a) Other deficiencies in diploma holders repeatedly pointed out are that they lack skills, practical job knowledge and the ability to apply and are ignorant of the actual requirements of industry.

(b) But the industries agree, nearly unanimously, that however, efficiently the systems of technician education and training may be organised, the diploma holders are not likely to exactly fit into the needs of the actual work done in industry without some kind of orientation and shop floor/field training. This is so because the practices and techniques, tools and equipment, and procedures vary in nature from unit to unit in the same kind of industry and from industry to industry and are also liable to changes from time to time. The organisational arrangements too are not of a standard pattern. Multiplying this diversity by the broad array of technician functions from design, drafting and development to maintenance and supervision one could see the dimensions of the problem of training the student to adequate technician job-competency. Most industries realise this and are prepared to organise orientation and induction programme and on-the-job training to new recruits. Even so they expect the diploma holder to have a good practical knowledge and skill concerning industrial techniques, procedures, tools, materials etc. so as to enable him to judiciously select and apply these in any particular situation.

(c) The capability of purely institutional education and training to impart such a competency is somewhat limited by the available equipment and facilities. In the institutional set-up the industrial atmosphere too is lacking. The practical work in the polytechnics, if well-organised, can give the training in basic manipulative and machine skills necessary to develop skill acquisition and appreciation. Facility in the judicial combination of skills and tools and the integrated application of knowledge and techniques to actual field operations can, to a large extent, be acquired only through properly planned and guided training in industry. Moreover, in the institutional practical work, the student lacks the inherent urgency and interest which characterise the work being done as a part of a production maintenance or business job. Planned practical work in a production shop or in a drawing office, where the activities are not merely exercises but stages of work which will end in saleable products, makes a difference in the intensity of motivation, assimilation and appreciation.

(d) For these reasons, the Committee recommends that efforts should be made by all concerned to provide practical training in industry for all diploma students. The several aspects of industrial training are discussed in Chapter IX.

(e) One of the best ways of linking industrial training with institutional education is through the organisation of sandwich courses. The training resources of institutions and industry are combined to conduct these courses, with the result theory and practice are closely correlated. The student's motivation is enhanced as work is coordinated with studies and he develops greater skill in human relations and a greater sense of responsibility. The transition from academic pursuits to the world of work becomes easier. Therefore, there can be no doubt that sandwich courses, if they are properly planned, organised and conducted, would be the best way of producing capable technicians. The Committee favour their progressive introductio in appropriate technician specialities wherever possible. However, the effective organisation of sandwich courses depends on several considerations both academic and practical. These considerations are examined in a later section.

(f) While the incorporation of industrial training as an important component of technician education is essential, it is equally necessary that adequate attention be paid to strengthening the practical content of the courses and giving them an industrial orientation.

(g) The practical content as prescribed in our present courses seems impressive, often occupying 60 to 70 per cent of the total time. In practice, however, the teaching and learning of technological practice have largely been ineffective. Important among the several reasons for this deficiency are: (a) a lack of clear understanding of the real meaning of practical work in the context of technician education (b) a theoretical teaching approach devoid of appeal to real situation (c) the lack of equipment and facilities (including adequate consumables) for stimulating industrial situations, work and activities and (d) the lack of practical experience, on the part of the teachers, in the work they are trying to teach.

(h) This calls for the adoption of new teaching approaches and the reorientation of institutional practical work to foster ability in application. The practical work must stimulate industrial or commercial conditions as closely as possible. Industrial experience for faculty and measures for industrial training of teachers also become vital. These aspects will be discussed further in later sections.

5.13. Need for Part-time and Other Courses

(a) Reference has already been made in chapter IV to the need expressed by industry for organising a variety of short-term and part-time educational courses for technicians and craftsmen working in industry in order that they may qualify themselves to work with greater competence. The Committee recognises the importance of such courses as the most effective method for the education of persons to fill the technician positions falling nearer the craftsmen.

(b) Industry has also stressed the need for organising special refresher and retraining courses in several areas for their technicians. The Committee recommends that while the major concern of polytechnics should be the running of regular diploma courses, they should also organise part-time, short-term and other special refresher and retraining courses, depending on the needs and situations.

(c) Apart from these courses, polytechnics should organise advanced diploma courses. The Committee feels that the provision of such opportunities to enable technicians to qualify themselves better will not only serve the interests of industry, but, more importantly, improve the promotional prospects of technicians and enhance their status.

(d) In this context the Committee feels it necessary to refer to the greater social recognition given to degrees and the wide-spread demand by technicians for the creation of opportunities to qualify for degrees. The technician education system must make due provision to meet this need. Therefore, the Committee recommends that certain selected polytechnics of acceptable standard having the necessary facilities, faculty and resources must be authorised to offer part-time degree courses. The State Council of Technical Awards—the machinery for the control of standards of technician education recommended in the later part of this chapter—may award these degrees. Such courses could moreover give scope for polytechnic teachers also to attain better status and opportunities.

5.14. Need for Flexibility in Course Planning

If the suggestions made so far about course reorganisation are to be effective, the courses must reflect the needs of regional, local and individual industrial and commercial units as closely as possible. Therefore, it is obvious that the courses and curricula of different polytechnics would not always be uniform. Moreover, the local conditions with regard to industrial training vary greatly and therefore, there can be no single uniform training arrangement. In view of these considerations, it becomes essential that, within the broad framework of certain general guidelines as regards the standards, objectives and scope of technician courses, there should be a great deal of flexibility in course planning to permit local variations in their structure, contents, and organisation. This necessity for flexibility gains further emphasis if it is agreed that technician education should continually adapt and modify itself to suit future needs and changes.

5.2. Courses

5.21. Course Patterns

(a) In line with the foregoing considerations the Committee recommends that polytechnics should organise a variety of courses as given below depending on the needs and situations. In organising the different courses, it is essential that coordination should be established in centres where more than one polytechnic exists so that duplication of effects may be avoided.

(b) Full-time Diploma Courses

(i) *General Courses*: General Courses are of the kind as exist at present in the fields of engineering and in commercial practice.

(ii) *Diversified Courses*: Diversified Courses have been defined earlier as those in which study-in-depth or specialisation in any of a range of broad sub-fields is built on a study of the fundamentals of the entire branch. Diversified courses should be organised in such institutions where the need for them has been fully established. These courses may be introduced in the initial stages by means of elective subjects within the broad-based diploma courses.

In introducing diversified courses, due regard should be paid to the pattern of employment in the major fields of engineering, commerce and business. In the field of civil engineering, for example, the major employers like the PWD and Government departments feel that there is no need for extensive diversification. However, other employers like the contracting firms, practising architects and consulting engineers have expressed the view that there is need and scope for some diversified courses in the civil engineering field.

In mechanical engineering and electrical engineering, where manufacturing industry is the major employer, there is a large demand for specialist technicians. There employment pattern in respect of technician level personnel in commerce and business also admits of some diversification in the related diploma courses. Introduction of diversified courses therefore implies a careful analysis, from time to time, of the activity of employing organisations and the job positions available therein and a precise description of the functions of technicians. For this purpose the Committee recommends the setting up of special cells in the Directorates or Departments in charge of technical education. Their functions would include the estimation of future technician demand, speciality-wise, on the basis of analyses of occupations. In India, the technician is frequently required to deal with tasks related to, but not necessarily part of, his functions. Therefore, in planning the diversified courses, we should look beyond the boundary of such occupational analyses. Courses must be planned to suit the needs of technician occupations in a cluster of closely related specialisations. A list of some of the fields in which diversified courses can be organised is given in Annexure 5.1. to this chapter.

(c) Sandwich Courses

In sandwich courses institutional education and industrial training alternate over the duration of the course. The sandwich periods may vary according to the nature of the speciality and the training arrangement that is best suited in any particular case. Experience suggests that 3 to 6 month sandwich periods are generally suitable.

The quantum of industrial training needed varies with different technician specialities; consequently, courses in certain specialities lend themselves better to the sandwich pattern. Sandwich courses should therefore be organised in such specialities where a proper balance and correlation could be achieved between the institutional education and the industrial training.

In organising sandwich courses, adequate arrangements should be made for proper instruction, guidance, supervision, assessment and evaluation during the industrial training periods. It is preferable to make the last period of a sandwich course an institutional period so that the final examination naturally falls at the completion of the entire course. It may, however, happen in some cases that the last period is an industrial period. In such cases the final examination should be held after the completion of the last period of industrial training. This is necessary in order to properly control and ensure the effectiveness of the last period of industrial training from the point of view of the course objectives.

The other conditions to be fulfilled in organising sandwich courses have been set out by Mr. Henninger and Mr. Houghton, the foreign consultants to the Committee, as follows:

1. There must be a relatively high and extensive concentration of suitable industries.

2. There must be substantial active support and participation by appropriate industries arranged well in advance, and definitely committed.

3. The participating industries must be comitted in advance to furnish proper instruction programmes, and to provide a system and competent personnel for the necessary supervision, instruction and progressive evaluation of each trainee.

4. The institution shall be committed in advance to furnish a competent and interested faculty member to serve full time in the plant for each group of at most 20 students to act as coordinator, counsellor and instructor and incidentally to learn for himself about industrial problems and practices.

5. Satisfactory allowances must be committed in advance by the institution on behalf of both faculty members and students to assure a reasonable timetable and work load properly in keeping with effective learning processes and normal social amenities.

Considering all the above aspects, the Committee recommends that efforts be made to secure the active and effective partnership of industry towards the progressive organisation of sandwich courses at selected centres and in certain specialised fields duly preceded by very careful study of all relevant factors. A list of suggested fields and locations for the introduction of sandwich courses in given in Annexure 5.2 to this chapter.

(d) Advanced Diploma Courses

These courses are for diploma holders who have been in service for at least one year. These courses, by and large, will be in fields of specialisation. The fields should be selected after a careful consideration of the industrial needs in any particular area. Some suggested fields in which advanced diploma courses may be offered are given in Annexure 5.3 to this chapter.

(e) Part-time Diploma Courses

a. General and diversified evening courses

b. Day-release courses

c. Block release courses

Part-time diploma courses should be organised for craftsmen and technicians who have been in service for at least 2 years. The courses should be so framed as to prepare them for the craft-based technician functions. In framing the curricula due regard should be given to the educational attainments, skills and industrial experience already possessed by these technician students. Courses should be started at the initiative and with the cooperation of industry in subject fields which will benefit a large number of skilled persons.

(f) Short-term and Special Courses

To meet the special needs of industry for retaining their technicians, short-term and special courses should be organised in suitable fields. Some suggestions in this regard have been made by various industries in response to the Committee's Survey of Industries.

5.22. **Types of Courses**

(a) Engineering Technology

Diploma courses may be offered in diversified areas of the major branches of Civil, Mechanical, Electrical and Chemical Engineering, Metallurgy, Textile Engineering etc. in addition to, or in place of, the general courses in these branches. A list of possible areas for offering diversified courses is suggested in Annexure 5.1 to this Chapter. The Committee emphasises in particular the need for organising courses in Electronics, Control Engineering, Metallurgical Engineering, Plastics Technology and Polymer Science and Technology , which are becoming increasingly important in present-day industry.

(b) Commerce-Business

Polytechnics should offer courses in commerce and business in so far as these are closely related to industry. A note on commerce and business education tracing its development and suggested line of reorganisation, with indications of the necessary courses, is given in Annexure 5.4 to this chapter.

(c) Courses in Girls' Polytechnics

A variety of courses suitable to the temperament and special aptitudes of girls sould be organised in Girls' polytechnics. These mav be offered in the following fields: Catering and Food Technology, Agricultural and Horticultural Extension Services, Pharmacy, Para-Medical Technicians, Medical Laboratory Technicians and X-Ray Technicians, Home Science and Home Economics, Architecture, Applied Arts, Interior Decoration, Radio and Television, Secretarial Practice, Business Administration, Commercial Practice etc. Other courses in the fields of Engineering and Commerce may also be offered if felt desirable. The Committee recommends in particular that diploma courses in Home Science and Home Economics options should be introduced in all Girls' Polytechnics.

(d) In respect of polytechnics situated in non-industrial urban areas, a careful study may be made of the types of courses required for these regions and, in the light of such study, suitable courses may be organised. However, these institutions may concentrate on offering generalised courses. Efforts should be made to set up industrial estates in the vicinity of such institutions to stimulate their growth.

(e) Polytechnics in rural areas may offer courses in agricultural engineering and courses applicable to agro-industries. In such areas the possibility of setting up industrial training institutes in the proximity of existing polytechnics may be considered with a view to augment the training facilities for students.

5.23. **Duration of Courses.**

(a) The Committee realises that the duration of courses may vary depending on the nature, pattern and type of courses. The Committee examined this matter very carefully and is of the view that in general the duration of a full-time diploma course should not be less than 3 years.

(b) However, for such courses as in the field of commerce and business a shorter duration can be considered if a careful study reveals that the required standards could be achieved within such shorter duration.

(c) For sandwich courses while the duration should be greater than for the regular courses they should not be of so long a duration as to make them unpopular. However sandwich courses have the advantage of effectively preparing the student to fit straightaway into the first technician job. Also, the periods of vacations in sandwich courses are shorter and thereby the time available for education and training is increased. After carefully examining these factors the Committee is convinced that duration of 3½ years should be sufficient in most cases.

(d) The following are the normal durations recommended:

Full-time institutional diploma courses :	3 years
Full-time sandwich courses at first diploma level:	3½ years
Advanced diploma courses . . :	1 year
Part-time evening courses at first diploma level :	Not exceeding 4 years*

*(Actual duration will be governed by the subject unit requirements)

The duration will depend upon the subject contents.

5.3. Admission Qualification.

5.31. There are at present three different schemes of polytechnic education based on the minimum admission requirements *viz.* the 3-year diploma course after matriculation or a Secondary School Certificate, the 2 year technician course after Higher Secondary Education and the 4-year sandwich course for chemical operators after general education up to the age of 14 years. All these schemes have been approved by the All India Council for Technical Education and are under implementation in the polytechnics. The main pattern however, is the 3-year diploma course which accounts for about 94 per cent of the total sanctioned admission capacity in polytechnics (excluding the Girls' Polytechnics).

5.32. Even with reference to the 3-year diploma course, the admission pattern varies from State to State depending upon the structure and stages of secondary education in the concerned State. In Madhya Pradesh and Delhi there is a 11-year school education leading to the Higher Secondary Certificate a pass in which is the qualification for admission to a polytechnic. In another group of States, comprising Andhra Pradesh, Bihar, Gujarat, Maharashtra, Orissa, Tamil Nadu, Goa and Pondicherry, the Secondary School Leaving Certificate is awarded after 11 years of school education but it is not of the same level as the Higher Secondary Certificate which is attained only after an additional year of education. Students are however eligible for admission to polytechnics in these States at the end of the 11 years of school education. Another case is that of Assam where the school education including a pre-primary stage extends to 12 years but terminates at the same level as at the end of 11 years in the above group of States. The States of Jammu and Kashmir, Kerala, Mysore, Punjab, Haryana, Rajasthan, Uttar Pradesh, West Bengal, Himachal Pradesh and Tripura provide yet another variation with a public examination held at the end of 10 years of school education, marking a definite stage. This is followed by an additional year or two, either as a part of the school system or of the university, aiming at the level of Higher Secondary or Pre-University stage. The polytechnics in these States take on those students who successfully complete the Class X examination. These various patterns of admissions and the consequent development of polytechnic education in the States have led to a great deal of difficulty on the part of industry to determine the standards expected of a diploma holder today. Another feature that was brought to the Committee's notice in this regard is that about 75 per cent of the students who apply for admission to polytechnics in some States have in fact completed Higher Secondary education or the Pre-University Course even though the minimum admission qualification prescribed is only Matriculation or its equivalent. For these students, most of the first year of he diploma course is a repetition of academic work n Science and Mathematics which they have already udied before joining the polytechnics.

5.33. In contrast, a situation in one of the States was referred to in which the first year of the diploma course is so designed that it would be equated to a Pre-University Course; the students could thus siphon off at the end of that year to join either a 3-year degree course in arts, commerce or science or a 5-year integrated degree course in engineering and technology. This sets at naught the concept of an integrated 3-year diploma course and seeks to imply that the diploma course should be completed in two years after the Higher-Secondary or Pre-University course.

5.34. The Committee has also observed the wide disparity among States in the standards set for the several stages of education; in one case, the course content of the Pre-University Course was reported to be much less than that prescribed by the Central Board of Secondary Education for the Higher Secondary.

5.35. After examining all these aspects, the Committee concludes that the basic approach to the laying down of minimum admission qualification should be, on the one hand, to keep the integrated nature of technician education and training intact and, on the other, to consider the general level of knowledge and maturity required to meet the demands of industry or to take the maximum advantage of the courses offered in polytechnics.

5.36. It has already been observed that industry needs persons who can plan, organise and supervise the work of skilled workers as well as those who can assist professional engineers or technologists in design, development and planning activities by taking over some of their simpler activities and performing them under their general guidance. Such types of technicians require a sound knowledge of the fundamentals of engineering or technology and a good level of science and general education. It has also been noted that the technologies involved in technician functions are always in a stage of transition. Unless a sound educational foundation is provided, problems of adaptation to changing technology will arise during the working life of technicians.

5.37. Keeping these trends and requirements in view, the Committee recommends that the minimum admission qualification for technician courses should be laid down as a pass in Higher Secondary Examination or its equivalent. In cases where students are to be admitted after matriculation, technician courses should be preceded by a preparatory course of one year after the matriculation examination on its equivalent. The details of this course, which will be the nature of a 'transfer' or a 'bridging' course, will be worked out by the concerned State Government through the proposed State Council of Technical Awards.

5.4. Curriculum

5.41. Principles

The following considerations are important in designing the technician curriculum:

1. The technician curriculum should comprise an integrated group of subjects of study arranged in proper sequence and leading to the general objectives of technician education and to the specific objectives of the technician specialities. While the curriculum should be designed primarily for the preparation of technicians, it should provide enough academic foundation for students aspiring to further their knowledge through self-study or through extension course leading to higher qualifications.

2. The curriculum should be built upon the level of attainment required at entry.

3. The curriculum should generally be the outcome of the joint and cooperative efforts of polytechnics and industry. Consultations with other engineering colleges and polytechnics could also be very valuable in this respect.

4. The curriculum should be flexible enough to permit addition or deletion of subjects and alteration in their levels and contents depending upon the pre-entry preparation, the varying needs of industry and the direction of technological change.

5. The syllabi should not only specify the topics but should also indicate the depth of their treatment.

6. When changes are to be effected in the curriculum, it is desirable to take into account the views and suggestions of students as well.

7. Provision must be made in the curriculum for self-study and independent work and for library work and consultations with faculty.

5.42. **Course Contents**

(a) The objectives of technician education have been discussed and it has been noted that any technician course should be broad-based and generally comprise (i) basic and applied sciences and mathematics, (ii) technical subjects and (iii) general studies.

(i) Basic and applied sciences and mathematics should enable the student to understand and learn the technical subjects that follow, but also lay the foundation for adaptability to changes and further studies.

(ii) Technical subjects both basic and specialised, should be included in appropriate proportion consistent with the requirements of the course. Technical subjects aim to impart the knowledge of technological principles and mastery of the techniques and skill and should comprise both theory and practical work.

(iii) General studies including language study should aim at developing communication skills, broad outlook and personal attitudes and qualities.

(b) In determining the breadth and depth of the scientific and technical subjects, it should be kept in mind that the technician need not pursue his fundamental studies to the same depth, nor does he need to study the applied and technological subjects in the same breadth, as the engineer or technologist. But within the particular range of specialised study, he should be much better equipped with practical skills and detailed knowledge of techniques.

(c) In technician courses, greater stress should be placed on developing practical competency and skills. Practical work should therefore from a substantial part of technician courses, particularly the full time regular courses. The elements comprising practical work may differ from field to field. In the field of engineering, for example, practical work will consist of work in the science laboratories and technical laboratories, design and drawing, and field work or workshop practice. Whatever the field, the basic requirement regarding the contents of practical work is that it should reflect similar work in industry, commerce or other field as far as possible within the limitations of institutional facilities.

(d) General studies should include the following:

(i) Study of language as an effective tool of communication.

(ii) Study in appropriate depth of topics from the following subjects as and where relevant: Industrial organisation, Factory laws, Labour laws, Human relations, Materials management, Industrial hygiene, Industrial safety, Concepts of systems engineering, Production control, Quality control, Cost Control, Standardization, Principles of economics etc.

(e) The Committee feels it necessary to stress that besides imparting specialised knowledge and practical orientation to the world of work technician courses should be designed to foster the development of personal qualities such as integrity, a sense of social responsibility, liberal values, a commitment to progress and adaptability to change. Moreover, education should help students to acquire an understanding of the social context in which they live and the processes of social change. To the extend possible therefore, general studies should also include subjects oriented towards developing an appreciation of the social and economic implications of science and technology anc industrial and commercial activity.

(f) The educational programme should also includ project work, seminars and co-curricular activitie aiming to develop in the student the confidence an competence needed for self-employment.

(g) The proportions of general studies, basic scier ces, applied sciences, basic technical subjects an specialised technical studies, and the ratio betwee theory and practical work will vary from course course within certain limits and should be careful determined in relation to the general objectives technician education and the specific requirements the particular speciality. The following pattern is suggested as a very broad indication of the relative percentage of contents in a diversified course:

General studies	*Percentage content*
(including languages, management subjects etc.)	10%
Sciences	
Mathematics, Basic Sciences, and Applied Sciences (including laboratories)	15% to 20%
Technical Studies	
Principles (theory)	
Basic Speciality (electives)	20% to 30%
Practice	
Design/Drawing Tech. Lab./Workshop Project and Field work	40% to 50%

(h) Some curriculum outlines are given in Appendix No. 6 and these may serve as illustrations of the way in which curricula may be planned for full-time, diversified and sandwich courses. It should be emphasised that the curricula given are examples only and should not be interpreted as recommendations or as ideal ones. Many variations are possible.

5.43. Sequence of Study

The basic sciences, applied sciences, languages, humanistic studies and the basic technical studies should generally be converted in the first two years. The electives should preferably be reserved for the inal year. Some topics of the general studies (for .g. industrial administration, economics, psychology, ndustrial hygiene, factory laws, and man-management) equire a certain degree of maturity and should thereore be carried over to the final year.

5.44. Orientation of the Educational Programme

(a) In framing the educational programme and elated activities, and more importantly in interpreng them in the actual teaching and course work, it ust be recognised that technician education should ress not only the acquisition of functional knowdge and skills, but also the development of the attides and abilities most valued by employers, namely, practical way of thinking, resourcefulness, an ability communicate, the correct attitude towards dignity labour and a sense of discipline.

(b) Teaching of technical subjects should be applition/industry-oriented. Science and Mathematics labi should be carefully matched with the requirents of the technical subjects. They should be ught as subjects interwoven into the other subjects the course and not as unrelated subjects as they so often regarded.

(c) The study of language should be emphasised as an effective tool of technical communication—oral and written.

(d) Besides the proper framing of curricula, several other steps are necessary to give an industrial orientation to the educational programme. Teachers must have considerable industrial experience and should be encouraged to keep in continual contact with industry in several ways. Increased attention should be paid to the matter of equipments and the use of teaching aids to make the teaching as realistic as possible. Project work based on actual industrial problems and the use of the problem method are indispensable. It is important to get as many experts from industry as possible to teach the technology courses on a part-time basis or under any other feasible arrangement. Their participation will be particularly valuable in guiding the project work. Arrangements should be made, wherever possible, for representatives from nearby industries to participate in seminars and deliver special lectures. They may also help polytechnics by supplying technical information, flow charts, detailed drawing etc. Visits to industries and work sites should be given due importance.

5.45. Laboratory Work

(a) Laboratory courses have a crucial and specific role to play in technician education programmes. Properly organised, they could contribute greatly to the understanding and appreciation of the principles and theory learnt and help the acquisition of ability in the application of knowledge and techniques. Unfortunately, in our polytechnics, the laboratory remains an aspect to which the least attention has been paid with the result that the educational potentialities have not been fully exploited.

(b) The three aspects of laboratory work which deserve serious attention in this context are: (i) the prescription of the laboratory courses in the curriculum (ii) the planning, organisation and evaluation of laboratory work by the teacher and (iii) the work and performance of the student in the laboratory.

(c) At present, the laboratory classes are normally assigned to junior teachers who do not teach the related theory classes. This practice must be immediately changed. Senior teachers who handle the theory classes should also conduct the laboratory classes. Properly trained laboratory assistants must be made available in each laboratory to give them the necessary assistance.

(d) The present laboratory courses in the various technical and science subjects are not properly planned to integrate them with the desired objectives of technician education. Some of the experiments included at present are absolutely unnecessary. For some others, demonstrations will be sufficient. Laboratory programmes should be formulated to develop an understanding of principles and concepts, acquisition of skills, mastery of techniques, ability in creative thinking and a practical way of thinking.

Laboratory programmes and experiments should be designed to give the student a clear idea of the measurement of various physical parametres he has to deal with, the instruments he has to use in his profession and the experimental techniques he has to apply. A laboratory programme cannot be organised properly without proper instructional material in the form of laboratory manuals. Laboratory manuals in the various disciplines suited to the needs of each course should be prepared. It may be mentioned here that when revised laboratory programmes are implemented some changes in the existing equipment pattern will become necessary. Some new equipments may also have to be procured or developed. Adequate funds should therefore be available to the institutions for this purpose.

5.46. Workshop Practice

(a) Since the polytechnic workshops are equipped only to impart the necessary fundamental skills, the Committee recommends that workshop practice should be designed mainly to give the basic training so as to lay the foundation for later shop floor experience.

(b) Basic training in Mechanical Engineering, for example, would include the basic skills related to metal forming, removal and joining, casting processes, heat and surface treatment of materials, methods of measurement, drawing, etc. Basic training should help the student to learn the correct use of hand tools and a variety of machine tools. He must at least be required to acquire appreciable competence in operating a few of them. This experience will enable him to understand better the interrelation of tolerances, piece work times, inspection and shop organisation. It must be understood, however, that the aim is not to give him the proficiency of a craftsman, but to make him appreciable the problems involved in manufacture, the posibilities and limitations of processes, the skill of the craftsman and the part played by long experience.

(c) Basic training should be based on sound teaching and this is in turn demands experienced and qualified instructors specifically trained for workshop teaching. In respect of existing workshop instructors, it is desirable that specially designed short-term courses be organised for providing them industrial training. The co-operation of the Central Training Institutes should be secured for providing training in respect of skill appreciation.

(d) In the workshop practice periods there must first be instruction on the principles underlying the tools or process being dealt with followed by experience on the part of the learner himself with the actual process or machine. The apprentice should not spend undue time on repetitive machine work or on the mere observation of process conducted by others.

5.47. Laboratory and Workshop Facilities

(a) The equipping of laboratories and workshops should be governed by a careful consideration of the needs of the courses, the teaching approach of the polytechnics and the availability of equipments in collaborating industry and the Industrial Training Institutes situated in the neighbourhood. The present practice of rigidly following "Standard" lists should be discontinued, although they could serve as guides of minimum requirements. Each polytechnic should determine the laboratory and workshop equipment it requires having regard to the nature of the courses offered from time to time.

(b) The Committee emphasises the need for keeping the polytechnics uptodate, as far as possible, with respect to equipment. Existing equipment should also be maintained in good working condition. Therfore, it is recommended that there should be specific provision in the annual budgeting for modernisation and replacement of equipment.

(c) Provision should be made for appointing component laboratory technicians in each laboratory for proper maintenance and upkeep of the laboratories and equipment. This would help the better and fuller use of the laboratoy facilities.

(d) Greater reliance should be placed on the faculty to develop and fabricate items of laboratory equipment needed for the courses and deserving proposals in this regard should receive financial support.

(e) Technical Teacher Training Institutes should collect details of equipment devised and fabricated by polytechnics and circulate the details to all polytechnics in the country.

(f) As regards the workshops, the Committee finds that the annual maintenance (contingencies, consumables) expenditure at present provided for, *viz.*, about Rs. 120 to 150 per student is grossly inadequate even to meet the expenditure on consumables required for organising an effective and comprehensive basic training. Calculations by the Committee indicate that the expenditure on consumables alone in a well-organised workshop course comes to the order of Rs. 375/- per student. The Committee therefore recommends strongly that, in the annual recurring expenditure, provision must be made for at least Rs. 300/- per student under maintenance and materials.

5.48. Project Work

Project work can be of the greatest value in stimulating and maintaining the student technician's enterprise and initiative. An ideal project should involve the application of the knowledge and skill already acquired, the exercise of judgment, an appreciation of the cost and human effort involved and the need for compromise. Properly selected project work fosters ability in the synthesis of knowledge and skills and their purposeful and critical use, and imparts an awareness of the several practical limitations in translating ideas into practice. The Committee recognises the importance of project work in technician education and recommends that project work requiring design and/or fabrication should find an important place in the final year of the diploma programme and in the advanced diploma course. Project work must be based on real problems involving industrial/commercial practices and procedures.

5.5. Teaching Methods

5.51. The present methods of teaching in the polytechnics consist of class room lectures, set exercises in laboratories, and design and drawing classes. By and large, these have not changed over the years. There is very little evidence of coordination between theory and laboratory practice. Although the syllabi of various courses prescribe tutorials, the implementation of tutorials has been far from satisfactory. In short, our system of teaching in the class-room consists only of information-feeding to the students without a provision for feed back at regular intervals. The present examination system disregards the role of assessment and evaluation as a powerful aid to learning. The lecture as a teaching method relies only on the appeal to the sense of hearing and disregards the other senses which are equally important in the learning process. Personal attention to the student is largely lacking. As a result, the present system of instruction is ineffective in developing mental skills and ability in the application and creative use of knowledge. Nor does the approach help the development of independent thinking and the spirit of enquiry or the habit of self-study. Moreover, the present approach is unequal to the challenge of teaching increasing amounts of course material within the limited duration of the course. If the quality of technician education is to be improved it is necessary to use more modern and effective teaching methods including the tutorial method, the problem-solving method, the project method and seminar method in our polytechnics wherever appropriate.

5.52. In our polytechnics, very little use is being made of teaching aids. Obviously there has been no attempt at a planned development of teaching aids. A concentrated effort is required to develop teaching aids and institutions should be provided with sufficient funds to acquire them. There has been,. however, some evidence, in recent years, of the development of teaching aids in various institutions of the country by individual teachers; but these individual efforts have not been exploited and coordinated properly and the aids thus developed in one institution are not available to other institutions. The Technical Teacher Training Institutes should take the lead in developing teaching aids and coordinate the efforts of other institutions so that, for each subject topic, suitable aids could be made available. In the immediate future, the preparation of slides, film strips, blow-ups, charts and films could be undertaken. Class-room demonstration models and instruction sheets should be prepared and produced on a large scale. These efforts are essential for better class-room instruction.

5.53. At present, the class-room teaching in polytechnics is largely concept-centred; problems from industry very rarely find entry into the class-room situation. The problem-solving approach is very essential if learning is to gain realism and students are to develop a practical way of thinking. Case studies for use in the class-room could be collected by the teachers in collaboration with industry. The Technical Teacher Training Institutes could compile these problems and bring out case books and catalogues of case studies. These should be made available to all polytechnics. Such case studies should be carefully examined and edited by experts before publication.

5.54. Attention also needs to be paid to saving the time spent in descriptive lectures. Increasing use should be made of textbooks, duplicated course materials, and hand-outs. One of the serious deficiencies noticed by the Committee is the present lack of suitable textbooks for technician students. Organised efforts must be made to develop textbooks and other supplementary course material suitable to the different technician courses. Incentives should be provided to teachers and experienced persons in industry to write such textbooks and material and to print and publish them at reasonably low prices. Textbooks in use should, moreover, be scrutinised from time to time and brought uptodate with reference to the latest technological changes.

5.6. Libraries in Polytechnics

5.61. There is hardly any evidence of self-study by the students in the various polytechnics. Self-study techniques involving library assignments are essential in raising the standard of students. This develops a proper attitude and confidence in the students and also helps them to tackle problems independently. Self-study habits also raise the level of activity in a class-room and ensure the active participation of students.

5.62. In this context the Committee stresses the importance of libraries in Polytechnics as an effective aid to intensify and support the educational process of teaching and learning. A high degree of integration of library services and resources with the instructional programme will change the motivational pattern of students to use the library as a source of information and reference and thereby promote their learning.

5.63. In our polytechnics, the students have not been made to appreciate the need for supplementing their knowledge by independent reading of books and journals. The students have rarely been guided and helped to learn how the books and journals in the library should be consulted. Besides, there has been very little conscious effort to devise schemes that will make the use of the library essential.

5.64. The formal education and training in the polytechnic should give the student not only the basic knowledge, skills, and attitudes in his chosen discipline but also impart a spirit of continuing education through his independent effort even after the cessation of his formal education at the polytechnic. Hence the polytechnics have the responsibility of training the student to keep himself continously abreast of developments in his field through the use of the library.

5.65. The state of libraries in most of our polytechnics is unsatisfactory. They do not contain the adequate number of books and journals for meeting the educational requirements of polytechnic students. There are no reading rooms. Other facilities too are conspicuous by their absence. In most of the libraries adequate attention has not been paid to appoint qualified and competent librarians.

5.66. The Committee therefore recommends strongly that all polytechnics should have well-stocked, well-staffed and attractive libraries. Necessary provision should be made for creating and maintaining adequate library facilities and services. Students must be trained in their effective use. Some suggestions and recommendations of the Committee regarding the physical facilities, staff, finance and administration and promotion of the use of libraries have been given in Annexure 5.5 to this chapter.

5.7. Need and Nature of Organisational Changes

5.71. Autonomy for Polytechnics

(a) The basic objective of the recommendations made on course reorganisation including diversification of courses, and the organisation of part-time and special courses is that polytechnic education should meet the needs of industry closely. Further, since technician education comprises partly institutional education and partly industrial training its effectiveness depends on close collaboration between polytechnics and industry particularly at the local level. In the context of the vast diversity of industries in respect of the technician functions therein and with regard to their capability for participation in the education and training of technicians, the basic objective can only be effectively met if courses are planned and organised at the unit level subject to certain general requirements regarding standards and levels. Technician education must moreover be sensitive to continual changes in technology and industrial practices. The development of technician courses on effective and proper lines is thus a process of continuous experimentation in which the teachers in the polytechnic and experts industry have to play a vital role.

(b) The Committee finds that the present system of academic organisation and control neither permits the flexibility in course-planning and course-organisation nor provides the freedom for polytechnics and teachers to experiment and innovate along new lines in collaboration with industry. The system offers very little opportunity for the faculty of polytechnics and experts from industry to effectively participate in the total process of technician education in its planning, development, organisation and assessment. Consequently the teacher does not feel that he is responsible for educating the student. Nor does he feel impelled to experiment with new teaching methods or to introduce the new developments into his teaching.

(c) Changes are therefore essential in both the aspects which characterize the present system of educational organisation, namely (i) the system of framing and prescribing uniform courses and curricula and (ii) the system of common external examinations.

(d) The reform of the examination system leading to complete internal assessment and evaluation by the institutions themselves is necessary because the concept of the common external examination is not consistent with freedom and flexibility in course planning. Besides, a switchover to continuous internal assessment is vital if education is to improve in quality and become purposeful. (This aspect is discussed in detail in chapter VIII).

(e) Keeping these considerations in view, the Committee is convinced that for the proper development and growth of technician education and its improvement in quality, autonomy for polytechnics is essential. Polytechnics should have complete freedom to experiment with much needed reforms, restructure their courses, establish cooperative relationships with industry in their region in training and employing technicians, develop the new curricula suited for such courses, evolve their own methodology for education and training and assess and evaluate their students.

(f) Some of the States have experimented with the grant of autonomy to selected polytechnics. The study of such polytechnics shows that by giving academic freedom the standard of instruction in those polytechnics and the quality of their products have considerably improved.

(g) The Committee therefore recommends that a beginning must be made by selecting atleast one but not more than two polytechnics in each State and Union Territory for the immediate grant of autonomy. These polytechnics must be selected on the basis of the sustained excellence of their standards, facilities, faculty and performance. Based on the experience gained with the working of the autonomous polytechnics initially selected, other polytechnics must be given such freedom as and when they are ripe enough to take up such responsibilities. For this purpose, the polytechnics must be assisted to attain the required standards and levels, through a phased programme of development over the next 10 years.

(h) If autonomy is to be meaningful, the autonomous polytechnics must be provided with the necessary administrative authority and financial resources. The principals must be delegated adequate administrative and financial powers to manage their institutions and implement new programmes. These powers are particularly needed for implementing the necessary measures of reform and development such as faculty development, improvement of laboratory and workshop facilities and other measures of quality improvement.

(i) For the proper exercise of the autonomy given to polytechnics and to plan and implement the development on the right lines the Committee recommends that each autonomous polytechnic should have a Governing Council and an Academic Board.

(j) The Governing Council will be responsible to guide and control the planning, development and administration of the polytechnic and should consist of teachers, representatives of local industry and representatives of the State Council of Technical Awards (recommended later), the State Board of Technical Education, the AICTE and the State and Central Governments. The principal of the polytechnic should be the member-secretary of the Council.

(k) The Academic Board will deal with such matters as assessment and evaluation, course development, relations with industry, research and other academic matter. The proposals of the academic board should be placed before the Governing Council for ratification. The Academic Board should consist of representatives of the faculty, experts from industry and eminent educationists in the fields of Technical and Secondary education. The principal of the Polytechnic should be the Chairman of the Board.

5.72. State Council of Technical Awards (SCTA)

(a) In granting autonomy to polytechnics, adequate arrangements must exist to coordinate and safeguard the necessary standard with respect to curricula, organisation and implementation of courses, and assessment and evaluation of students. Moreover, it is necessary to guide, help and oversee the progressive development of the autonomous polytechnics, and also to evaluate their performance on a continuing basis and feed back the information to the concerned agencies which are in immediate charge of technical education.

(b) With the above considerations in view, the Committee recommends that an independent and autonomous body that may be called the State Council of Technical Awards should be set up in each State.

(c) The SCTA will set and assess standards not by framing and imposing courses and curricula and by conducting examinations, but by inspecting and approving institutions, scrutinizing and approving the new courses and curricula (or changes in existing ones) and the schemes of assessment and evaluation framed by the polytechnics themselves. The Council will thus act as the guardian of the standards of courses, curricula and performance of polytechnics.

(d) The State Council of Technical Awards will work through appropriate subject panels, standing committees and inspection commissions set up by it. The Council will establish the guidelines and detailed procedures in regard to the approval of courses. institutions and evaluation systems. It will have the power to inspect the polytechnics, their faculty and facilities, their methods of teaching, the arrangements for training, and the records of assessment including valued answer books etc. Once a course and institution are approved and the Council is satisfied with the system of evaluation it will award the diplomas to the students as recommended by the institution.

(e) Since the grant of autonomy to polytechnics will be a phased process to be completed within the next 10 years, the SCTA will have further responsibilities within this 10 year period in respect of polytechnics yet to gain autonomous status. In respect of such poytechnics, the SCTA will help them to frame and change their courses and curricula, conduct the external examinations and suggest the methods of internal assessment to be followed. In this sense it may take over the functions of the present Board of Studies and Board Examinations of the State Board of Technical Education.

(f) The Council will assist these polytechnics to develop the standards of facilities, performance, and expertise needed to gain autonomy by making suggestions for improvement and development in various aspects. To this end it may also be an advisory body to the Government.

(g) The Committee feels that the best interests of technician education will be served only if the SCTA is an independent and autonomous body consisting of experts and representatives of the various interests concerned. with a non-official chairman, so that it could work effectively and with expedition. The awards made by such a body would moreover enjoy public recognition and the confidence of industry.

(h) The Committee has recommended earlier that in order to enhance the status of technicians, opportunities should be provided for part-time degree courses and that selected polytechnics should be authorised to conduct such courses. It is important that polytechnics should have the opportunity to grow and develop along new lines and acquire the stature and position due to them in the impending field of technical education. The Committee envisages a vital role for the State Councils of Technical Awards in this development. In the not-distant future the Councils could develop into important organisations for the award of degree of national standard, both undergraduate and postgraduate for students of institutions of higher education, post-matric education and polytechnics. In this process they should maintain their essential character, constitution and approach which is to safeguard high standards without restricting the freedom and flexibility in course planning and the autonomy of institutions.

(i) The broad framework of the constitution, functions, and working of the SCTA is suggested in Annexure 5.6 to this chapter.

ANNEXURE 5.1

SOME SUGGESTED AREAS FOR DIVERSIFIED COURSES

Civil Engineering:	General Civil Engineering Public Health Engineering Construction Technology Estimating, Detailing, Drafting Architectural Assistantship.
Mechanical Engineering:	GeneralMechanical Engineering FoundryTechnology Welding Technology Production Technology Design and Drafting Technology Mechanical Machinery Maintenence Automobile Engineering (Repair and Maintenance.) Refrigeration and Air conditioning Fluid Machinery Power Plant Engineering.
Electrical Engineering:	General Electrical Engineering Maintenance of Electrical Machinery and Systems Manufacture of Electrical Machinery and Components Industrial Electronics Electrical Generation, Transmission and Distribution (Power Systems) Communication Engineering.
Chemical Engineering :	General Chemical Engineering Ceramics and Plastics Technology Petroleum Technology Paint Technology Industrial Chemistry Textile Chemistry
Textile Engieering and Manufacture:	General Textile Technology Cotton Yarn Manufacture Fabric Manufacture Textile processing and finishing Man-made fibre Yarn Manufacture.
Metallurgical Engineering:	Hot and Cold Rolling and Metal Forming Processes. Fuel and Furnace Technology Foundry and Forge Technology
Commerce and Business Education : (See also Anexure 5.4).	Commercial Practice Secretarial Practice Office Administration and Data Processing Sales and Marketing Banking and Insurance Advertisement and Display
Agricultural Engineering :	Agricultural Engineering Farm Machinery and Equipment Agro-industries options.
SOME OTHER COURSES	Mining Engineering Printing Technology Printing Processes Film Technology Graphic Reproduction Processes Wood Technology Rubber Technology Clothing and Apparel Manufacture. Paper and Pulp Technology Catering Technology Food Technology

ANNEXURE 5.2

SANDWICH COURSES

(A) *Specialities*

A few of the specialities in which sandwich courses may be started are suggested below. (The list is not exhaustive).

Mechanical Engineering : .	Foundry Technology Machine Tool Technology Production Engineering Sheet Metal and Welding Technology Agriculturl Engineering and Farm Machinery Automobile Engineering Tool Design Technology
Electrical Engineering :	Instrumentation and Control Systems Generation and Distribution Electronics Electrical Machinery
Civil Engineering : . .	Construction Engineering Architecture
Chemical Engineering : .	Petro-Chemicals Oil Refining Fertilisers and Acids
Textile Technology: . .	Man-made fibres Cotton Textiles Spinning, Weaving, Bleaching Dyeing
Printing Technology : . .	Printing Technology Printing Processes

(B) *Location*

At present it may be possible to start sandwich courses in the centres noted below and in the fields noted against each. This list is only suggestive and it is subject to variation according to local needs and requirement.

Bombay	Automobile Engineering Production Engineering Electronics Printing Technology Chemical Engineering

Calcutta	Foundry Technology Production Engineering Printing Technology
Madras	Sugar Technology Foundry Technology Petroleum Technology Architecture Printing Technology
Bangalore	Production Engineering Electrical Machinery Manufacture. Machine Tool Technology
Coimbatore . . .	Foundry Technology Production Technology Machine Tool Technology Spinning and Weaving Textile Technology
Ahmedabad . . .	Textile Technology Spinning and Weaving
Bhopal	Production Engineering Drafting and Design Instrumentation and Control
Hyderabad . .	Electronics
Ranchi . . .	Production Engineering Metallurgical Engineering.
Delhi	Construction Technology
Ludhiana	Farm Machinery
Trichy	Mechanical Engineering
Waltair	Chemical Engineering Marine Engineering Ship Building
Kalamassery . . .	Machine Tool Technology Chemical Engineering

ANNEXURE 5·3

SOME SUGGESTED AREAS FOR ADVANCED DIPLOMA COURSES

Civil Engineering . .	Concrete Technology and Structures Architectural Design and Drafting Town Planning
Mechanical Engineering .	Instrument Technology and Control Engineering Tool Design Engineering Heat Treatment Air-craft Engine Maintenance Workstudy and Industrial Engineering
Electrical Engineering	Instrument Technology and Control Systems. Illumination Engineering Sound Engineering
Textile Technology and Manufacture.	Textile Machine Maintenance and Statistical Quality Control. Textile Chemistry.
Chemical Engineering . .	Petro-Chemicals Polymer Science and Plastics. Plant Design.

ANNEXURE 5·4

COMMERCE AND BUSINESS EDUCATION

The Special Committee for Commerce Education under the Chairmanship of Dr. V. K. R. V. Rao recommended as follows:

> "In order to provide efficient personnel in business and commerce as also to reduce the present rush to colleges for training for commerce occupations, we recommend the institution of the National Diploma in Commercial Practice or D.C.P. The course should be spread over two years and be strictly vocational in content and training and the subjects taught should include English, Regional language, Commercial Arithmetic, Commercial Geography, Elements of Commerce. Typewriting and Elementary Book-keeping with one of the following as optional: Short-hand, Banking Practice, Accountancy, Secretarial Practice and Salesmanship. Admissions should be confined to those who pass High School or Matriculation wherever these exist or the tenth class where the Higher Secondary Course has already been introduced".

Action taken since the VKRV Rao Committee Report

The Sub-Committee of the All India Board of Technical Studies in Commerce prepared the curriculam and syllabus for a two-year Diploma Course in Commercial Practice. The subjects under the compulsory group were: English, Commercial Arithmetic, Commercial Geography, Elements of Commerce, Book-keeping and Elements of Accountancy, Elements of Business Organisation and Management including Office Management, and Typewriting.

The electives, of which one had to be chosen, were: Banking Practice. Insurance Practice, Secretarial Practice, Shorthand and Typewriting in English or Regional Language, and Salesmanship and Marketing.

The Sub-Committee suggested that "Apart from reorganising the existing commerce schools on these lines, the need for additional commerce education in a State should be met as far as possible by setting up commerce departments in polytechnics rather than by establishing new schools as separate and independent institutions".

Subsequently, for several reasons, further changes were made both in the duration of the course and in the scheme of examination. In Madras, for example, the duration was increased from two years to three years and the first year was modelled after the Pre-University course.

Reorganization

In the context of the reorganization of polytechnic education, courses in commerce education have also to be organised to bring them to the technicians diploma standard. The courses must reflect the needs of technician level occupations in Business and Commerce. Since industry and trade are complementary activities, commerce also follows broadly the pattern of developments in industry. Technological advances are leading to new and sophisticated methods and techniques in commercial and business organization and administration. These in turn have created an increasing demand for trained personnel at the technician level in Commerce and Business. Diploma courses should satisfy these current and future demands.

Curriculum

Courses in Commerce and Business may be diversified with suitable groups of subjects in the following areas as electives:

Advanced Accounting and Auditing
Cost Accounting
Incometax Practice
Stores, Purchase and Control
Materials Management and Transportation
Inventory Control and Store Layout
Market Study
Advertisement and Display
Export and Import Business
Distribution Trade
Insurance and Banking
Company Law and Company Secretarial Practice
Factory Laws, Regulations
Data Processing
Office Equipments and Systems

In diversifying the courses, the aim should be to frame programmes suitable for such occupations as below:

Senior Secretaries and Personal Assistants, Office Supervisors, Sales Supervisors, Purchase and Stores staff, Junior Accountants, Senior Specialist Clerks, Organization and Methods assistants, Marketing and Market research assistants, Computer Programmers, etc. working in such specialised professional fields as Accountancy, Retailing, Costing, Computer Programming, Data Processing, Insurance, Banking, Taxation, Transport, Real Estate and Legal Executive work.

It is desirable to have in each subject a list of topics on which practical work will be done in the class room or in the business laboratory/office.

It is also necessary to examine the scope for sandwich courses for Commerce students.

ANNEXURE 5.5

LIBRARIES IN POLYTECHNICS

Buildings and Furniture

A majority of polytechnic libraries do not have adequate space to satisfy the operational and educational requirements. In most cases they lack reading rooms with adequate seating capacity. In the future design of libraries adequate provision must be made for reading rooms, office room, space for storage of books and display of journals and service areas, keeping in mind possible future expansion. The reading rooms should be well furnished lighted and ventilated.

As a broad guideline reading rooms may be designed for a seating capacity of at least 10 per cent of the student body.

Library Staff

The recognition of the important role of the library as an essential part of the education system demands that it should have a well qualified, competent and well-paid librarian with adequate staff to assist him.

Hitherto, the position of the librarian has not been clearly appreciated and he has been thought of as someone 'looking after the books'. As the library has an important educational role, it is necessary that the librarian should be given the recognition and appropriate status due to him as an important member of the academic team. The Committee recommends that the librarian should be given a grade at least equal to that of a Lecturer and granted the status of the Head of Department. The Librarian should serve on the Committee of Heads of Departments to be able to develop the library services in conformity with the changing needs of the polytechnics.

Additional staff will be required to supervise the library throughout the day, to issue books, to look after their return, to shelve the books, to assist readers, to check books and periodicals, to prepare accession lists, to collect overdue books, clean the halls and to carry out a host of other routine duties. Due provision should also be made for staff for overtime work.

Finance and Administration

The financial requirements of the library depends on the range of courses offered, the size of the student body, the nature of services to be offered and the procurement policy regarding books and journals.

However, the Committee would suggest the following as a guideline in equipping and maintaining a library in a polytechnic with a strength of about 500 students.

Initial number of books	5,000
Annual expenditure on new additions	Rs. 20,000
Annual expenditure on journals	Rs. 10,000

Suitable modifications of these figures will be necessary depending upon the number of students, number of courses etc.

The library exists for the benefit of the readers and the administrative procedures should be streamlined to serve this end. There should, no doubt, be rules to govern the borrowing of books, discipline in the library, readers' entry and leaving etc., but these should be carefully examined from time to time and restrictions kept to the minimum consistent with the need for maintaining efficiency. The open access system is preferable.

The Promotion of Library Use

It is not merely enough to stock the library with adequate books and journals and to man it by competent staff. Polytechnics must find means to derive the greatest benefit from the library. The Committee therefore makes the following suggestions for the promotion of library use.

1. Libraries must be kept open for at least 4 or 5 hours longer than the normal working hours of the polytechnics. It must remain open on Saturdays and during the vacations.

2. The librarian has the key role in the promotion of library use. He should assign all routine duties to the other staff and make himself free for more creative work, guidance and promotional activities. He should have an insight into academic attitudes and methods of study and a desire to serve the readers. He should also be fully familiar with the proper classification of the literature available in the library. For this purpose he should have undergone proper orientation training in the organisation and management of a technical library.

3. It is incumbent on the part of the librarian to familiarise the potential users with the available resources. Besides stencilled guides, the librarian will have to usually rely on introductory talks involving demonstration of catalogue components and the classification scheme and explanation of loan facilities and procedures. For the first year students, intensive guidance and orientation are necessary to familiarise them with the library set up and the use of the library. Those teachers really interested in library work and well-acquainted with the students' needs and intellectual levels may also be involved in this orientation work.

4. In some cases, personal attention and guidance may be necessary. The subject teacher and the librarian may help the individual students in solving their problems. They can help the students in the search for information and materials.

5. Individual or group projects or term papers should be set in such a way as to make it necessary for students to have recourse to library sources.

6. The teacher should give reading lists covering his lectures. Such lists should be compiled for all subjects and made available to the students.

7. The library should contain carefully selected books in humanities and social sciences. Reading these books will instil liberal values and broader outlook in the students. Reading for pleasure, self discovery, and personal growth should be encouraged and cultivated among the students.

A majority of students in the polytechnics come from poor families and many cannot afford to possess text books of their own for all subjects. Therefore, there is a need for separate textbook libraries in the polytechnics and, if possible, in the Halls of Residence.

ANNEXURE 5.6

CONSTITUTION AND FUNCTIONS OF THE STATE COUNCIL OF TECHNICAL AWARDS

Constitution of the Council

The State Government should determine the manner and method of setting up the State Council of Technical Awards and specify its relationship to the State Board of Technical Education. The Council should consist of the representatives of industry, trade and commerce, technical experts from Government departments, representatives of the professional bodies, progressive educationists, polytechnic and college teachers and principals etc. It is also recommended that the Chairman of the Council should be a non-official, preferably a distinguished educationist or a progressive industrialist, interested in the promotion of technical education.

The Director of Technical Education in each State should be the Member-Secretary of the Council and his Directorate should be responsible for giving secretariat assistance to this organisation.

The State Council of Technical Awards may constitute separate subject panels for each field of studies to advise it on matters related to the concerned field. The subject panels should consist of experts in each field drawn from polytechnic teachers and industry. All academic matters relating to the concerned field should be referred to these panels of experts and on their advice the Council may take such action as it deems necessary. The Council may be empowered to draw upon the expertise and experience of persons not only within the State but also in other parts of the country as and when necessary. The Council will constitute appropriate inspection commissions for inspecting polytechnics, their faculty, facilities and working, including their assessment and evaluation system, for purposes of approval of institutions and courses, or for periodic review.

Functions of the Council

The Committee recommends that the Council should have the following functions:

(i) To lay down the standards required of polytechnics by way of physical facilities, faculty etc. and the general guidelines and requirements for courses with due regard to national standards and coordination.

(ii) To select polytechnics for the grant of autonomy.

(iii) To scrutinize and approve, or suggest modification of courses and assessment systems framed by autonomous polytechnics and to help and guide them in implementing reforms, experiments and projects.

(iv) To recognise polytechnics for its awards on the basis of inspection.

(v) To help polytechnics not granted autonomy to frame courses and curricula and to guide and advise on their progressive development.

(vi) To conduct external examinations for polytechnics not granted academic freedom and to devise the system of internal evaluation and assessment for them.

(vii) To conduct research on all aspects of technician education and suggest improvement to all polytechnics.

(viii) To award diplomas to students passing out of all polytechnics.

(ix) Any other functions which may be entrusted to the Council by the State Government or the All India Council for Technical Education.

The Council should function as an independent, autonomous body in respect of academic matters stated above. However, it should also act as an advisory body to the State Government/State Board of Technical Education in all matters connected with technician education and training.

CHAPTER VI

6.0. FACULTY

6.01. In the reorganisation of any educational system to make it more meaningful and purposeful, the teacher who is the key element in the system, deserves important consideration. The success of any educational system depends upon the supply of properly trained, experienced and devoted teachers in adequate numbers. In the field of polytechnic education another essential qualification required of a teacher is adequate industrial experience. According to a survey conducted in 1969, a majority of the teachers of polytechnics have very little or no industrial experience. This lack of industrial experience in the teachers is one of the main reasons why polytechnic education, at present, is not sufficiently application-oriented.

6.02. In an ideal situation, the teachers in technical institutions at all levels should be able to guide or advise industry in the matter of the adoption of new techniques and new processes. To that end, the polytechnic teacher must be in constant contact with industry and should have a first hand knowledge of the processes, techniques etc. used by industry as also an idea of the problems faced by it. Familiarity with current practices, problems and development trends in industry would help teachers bring in a better approach and orientation to teaching.

6.03. In improving the faculty position in polytechnics, one has to consider its several integral aspects such as staff structure, qualifications, industrial experience, conditions of service, salaries and faculty development. Factors such as the type of teachers available, the methodology of teaching adopted, the staff-student ratio, and the facilities available for upgrading the knowledge of the teachers and for providing industrial exposure, influence the building up of a proper faculty. All these aspects are considered in this chapter.

6.1. Present Staff Structure and Qualifications

6.11. The staffing pattern as laid down by the All India Council for Technical Education for a polytechnic conducting diploma courses in Civil, Eletrical and Mechanical Engineering with an annual intake of 120 students or a total student strength of the order of 300 to 400 is given below:

Designation 1	*Qualifications* 2
1 Principal . . .	(*i*) Bachelor's Degree in Engineering or Technology (or equivalent) Or AMIE (By Examination) Or TTTI Diploma (*ii*) 8 years professional and/or teaching experience. (*iii*) Industrial experience preferable
2 Head of the Department	(*i*) Bachelor's Degree in Engineering or Technology (or equivalent) Or AMIE (By Examination) Or TTTI Diploma (*ii*) 5 years' professional and/or teaching experience. (*iii*) Industrial experience preferable.
3 Lecturer (Technical)	First Class Diploma in Engineering and TTTI Diploma Or Bachelor's Degree in Engineering/ Technology or equivalent } with 2 years industrial experience Or AMIE (By examination)
4. Lecturer (non-technical)	Master's Degree in the subject with 2 years' teaching experience.
5. Workshop Superintendent.	First Class Diploma in Engineering with 8 years' workshop experience. NOTE : In the absence of candidates with the above qualifications, candidates with a Bachelor's degree in Engineering with 5 years' experience may be considered.
6. Senior Instructors/ Assistant Lecturers.	First-class diploma in engineering with at least two year's industrial and/or teaching experience Or Degree of Bachelor of Technology/ Education of the Regional Colleges of Education at Mysore, Bhopal Bhubaneswar and Ajmer with at least two years' industrial and/ or teaching experience.
7. Junior Instructors/Demonstrators.	First-class diploma in Engineering or degree of Bachelor of Technology/Education of the Regional Colleges of Education at Mysore, Bhopal, Bhubaneswar and Ajmer.

The above qualifications for Senior Instructors and Junior Instructors are applicable only when these posts are on the teaching side and not for Instructors in Workshops. As for Workshop Instructors, the qualifications and experience should be specified in terms of ITI certificates or Junior Technical School Certificates or appropriate competence in the concerned trades.

6.12. If all the categories of staff mentioned above are taken into consideration, the present staff-student ratio comes to about 1:12. In calculating the staff-student ratio, normally the teaching staff only is considered which, in this case, would comprise the Heads of Departments, the Lecturers and the Instructors for Science and Mathematics. Even if the Demonstrators are considered as teaching staff the actual staff-student ratio works out to about 1:20.

6.2. **Salary Structure**

6.21. The salary scales for teachers in polytechnics as recommended by the All India Council for Technical Education and normally adopted in various polytechnics are given below:

Designation of Post	*Salary Scale*
Principal	Rs. 800-40-1000-50-1250.
Head of the Deptt. (Lecturer-in-charge) . .	Rs. 600-40-1000.
Lecturer	Rs. 350-350-380-380-30-590-EB-30-770-40-850.
Workshop Superintendent .	Rs. 350-350-380-380-30-590-EB-30-770-40-850.
Senior Instructor . .	Rs. 260-20-300-15-450-25/2-500.
Junior Instructor . .	Rs. 160-10-300.

6.22. In comparison with the salary structures in engineering colleges and other sectors of employment, the salary structure of the polytechnic teachers is rather poor. The Committee recommends that the present disparity in salary structure between polytechnics and engineering colleges should be removed. It is therefore recommended that the salary scales and designations of teachers in Polytechnics should be the same as those prevailing in the engineering colleges.

6.3. **Recommended Staff Structure**

6.31. The Committee recommends that the normal pattern of teaching staff categories in a polytechnic should be as follows:

Professor or Head of the Department;
Assistant Professor; and
Lecturer/Associate Lecturer.

The ratio between senior positions and junior position, *i.e.*, Professors/Assistant Professors and Lecturers/Associate Lecturers, should be of the order of 1 : 2.

6.32. To improve the quality of polytechnic education, it is recommended that as far as possible the strength in lecture classes should not be more than 30 students. In laboratories and workshops, the number of students per teacher should be restricted to 10. The same may be the case with the tutorial classes. As far as possible not more than two students should be put in a batch for conducting experiments.

6.33. Teachers of theory classes in a subject should also be made responsible for organising and conducting the laboratory courses in the subject. Theory classes should not normally be handled by teachers lower in rank than lecturers.

6.34. In order that the tutorial system, laboratory teaching and project work may be effective, the present teacher-student ratio should be raised to not less than 1:10. In counting this ratio, only teaching posts of Associate Lecturers and above should be taken into account.

6.35. It is recommended that for every diversified course in an institution at least one Professor assisted by an Assistant Professor or Lecturer be provided, supplemented by part-time lecturers from industry.

6.36. Coordination of courses in polytechnics in close proximity could help the use of highly qualified staff in the most efficient manner.

6.37. Principals and Heads of Departments of polytechnics should be provided with suitable administrative staff so that educational efficiency could be increased. More generous provision should be made of clerical and laboratory assistance to teachers.

6.4. **Staff Qualifications**

6.41. Considering the various aspects of polytechnic education and the reforms suggested in this report, the Committee recommends that teachers of technical subjects should have the following minimum qualifications:

(a) Associate Lecturer:	A degree in engineering or technology with at least two years of industrial experience. However, a diploma holder with not less than five years' industrial experience in the field may also be considered subject to his suitability to teaching and improving his academic background through teacher-training programmes and/or extension/summer school courses.
(b) Lecturer and above : .	A degree in engineering or technology or equivalent, with three years of industrial experience, or Diploma of TTTI training with five years of industrial experience.

6.42. For teachers of professional courses like Commerce, etc. the minimum qualification should be a degree in the appropriate field with two years of professional experience in the field.

6.43. For teachers of other subjects like the Sciences, Humanities etc. the minimum qualification should be a post-graduate degree, preference being given to persons with industrial experience.

6.44. For all polytechnic teachers, training of at least one year in the art and technique of teaching technical subjects is desirable.

6.5. Essential Conditions of Service

6.51. It is recommended that all teachers of similar categories, irrespective of their subject-field, should be given the same scales of pay and benefits.

6.52. With a view to attracting better type of staff in polytechnics and retaining them, it is recommended that a composite scale, with suitable stages of entry for each category, should be prescribed for all teachers starting from the Associate Lecturer to the Assistant Professor.

6.53. In order to make the teaching of sciences, mathematics, languages, etc. more effective and application-oriented, the practice of transferring staff between polytechnics and arts and science colleges, wherever it exists, should be discontinued.

6.54. Provision should be made for suitable incentives to encourage serving teachers to augment their academic qualification and experience.

6.55. The Committee is of the view that there should be adequate provision in the service conditions of teachers for obligatory periodic in-service training so that the authorities may send any teacher for in-service or industrial training as and when needed. When teachers are deputed for such training, they should be paid their full salary in addition to travelling allowances and stipends.

6.56. Teachers should be given the freedom to take up consultancy work. Constultancy and research work will provide opportunity for the self-development of teachers. To regulate such work, proper code of conduct should be drawn up by the institutions.

6.57. There should be provision for sabbatical leave for teachers to pursue research or write books or work in industry. Liberal grants should be made to polytechnics to enable teachers to pursue research work in their own spheres of specialisation.

6.58 In planning new accommodation, due attention should be given to the provision of amenities and residential quarters for staff.

6.6. Part-time Teachers from Industry

6.61 The use of part-time teachers drawn from industry, commerce and the professions constitutes a major means of maintaining the essential contact between education and industry and of ensuring that teaching takes account of day to day industrial and commercial experience and of the latest developments.

6.62. It is in the more highly specialised and advanced fields like industrial design and studies involving production techniques and practices and in guiding project work that the services of part-time teachers are especially valuable. In order to attract senior staff of the calibre required, it would be necessary to offer them a special place in the polytechnic life besides adequate remuneration.

6.63. Industry must be willing to accept, encourage and assist the transfer of experienced staff to part-time and full-time teaching work. There must be a much greater interchange of staff between industry and polytechnics.

6.7. Faculty Training

6.71. Opportunities should be made available to teachers for acquiring the needed industrial experience, pedagogic training and higher academic qualifications, through seminars, short-term courses of various kinds, summer institutes, in-service training programmes, deputation to Technical Teacher Training Institutes during vacation or during the academic year and secondment to industries. Teachers must be required to attend such courses and acquire such training several times during their career to facilitate continuous development and updating.

6.72. Specially designed short-term courses should be organised for providing industrial training to workshop instructors. The co-operation of Central Training Institutes should be secured for providing training in respect of skill appreciation.

6.73. A crash programme for re-training at least 25 per cent of the existing polytechnic teachers (particularly the experienced teachers) within a period of two years, should be formulated by each State authority in association with the Technical Teachers Training Institute or other appropriate agencies. This will consist of several courses of short duration on such subjects as examination and evaluation system, teaching methodology and techniques, curriculum development and organising laboratory work, as well as courses for providing industrial orientation.

This crash programme should be followed by a second stage of comprehensive industrial training especially for teachers in certain subjects which are highly practice or industry-oriented.

A third stage of longer duration should cover training in communication skills.

6.74. A crash programme should be organised, at selected centres in India, for principals of polytechnics to familiarise them with the different aspects of the reorganisation of polytechnic education and management as recommended in this report relating to sandwich courses, diversified courses and special courses and new techniques in imparting education and implementing training programmes, new systems of evaluation and grading, teaching aids, subjects for new courses to meet the latest technological needs, administration and management of institutions etc. This programme will help the principals of polytechnics to translate the suggested reforms and new developments into actual practice in their institutions.

6.75. Teachers of Language, Mathematics and Physical Sciences should be given special orientation courses to make their teaching more effective.

6.76. Each State may:

(a) assess the total number of teachers to be trained annually say in the first ten years.

(b) indicate the type of training programmes relevant to Instructors, Associate Lecturers and Heads of Departments to be planned for, and

(c) work out financial estimates.

These measures will enable the implementing authorities to plan phased programmes. In this regard, the appropriate advisory machinery should advise the Government on the supply and training of teachers for polytechnics. This machinery should continually review the arrangements and provisions for training and keep in touch with polytechnics about supply and demand for teachers and demand for different types of training courses.

6.77. Closer participation and exchange of ideas on the pattern and content of teacher training is essential between the world of technical education, industry and commerce and universities.

6.8. **Role of Technical Teacher Training Institutes**

6.81. The courses at the Technical Teacher Training Institutes should emphasise the training of teachers in the several aspects of polytechnic education and training rather than advanced subject studies.

The main functions of Technical Teachers Training Institutes should be:

(a) Organisation of courses on the art and techniques of teaching and special subject-teaching courses;

(b) Research on methods of assessment, evaluation and grading and the training of teachers in these techniques;

(c) Research and training in teaching methods and development and production of teaching aids, charts and publication;

(d) Collection and dissemination of information on curricula, examination system, equipment, teaching aids, technical literature, teaching methods etc. to all polytechnics in the country.

The Committee commends the good and useful work now being done in the Technical Teacher Training Institutes. The Committee feels strongly that they can serve better in the field of teacher training if they concentrate their energy on it instead of proliferating their activities in other fields.

6.82. In order to effect all round development, close liasion should be established and maintained between the Technical Teacher Training Institutes on the one hand and the principals and senior faculty members of polytechnics on the other. It would also be desirable to make use of senior faculty members deputed from polytechnics for limited periods of time to teach and work at the Technical Teacher Training Institutes. The work of teaching in polytechnics is undergoing continual change in response to changes in the methods and processes of industrial production. To respond to such changes the staff of the Technical Teacher Training Institutes should not only retain a close association with neighbouring polytechnics but should also be in touch with industry. For this purpose, they should be encouraged to return periodically to plytechnic teaching and to industry.

6.83. Technical Teacher Training Institutes should be outward looking and provide extension services in different centres. They should organise short term courses for lectures and instructors on the fabrication and use of teaching aids.

CHAPTER VII

7.0. STUDENTS

7.1. Admission Requirements

7.11. The quality of technicians prepared by polytechnics will greatly depend upon the quality of the students admitted. Therefore, the selection of students for polytechnic courses needs very careful consideration so that they may derive the best advantage from the education and serve the best interests of industry. In the technically advanced countries, students enter technician institutions at a more mature age than in India. During the Committee's discussions with the various authorities and persons involved in polytechnic education and with the foreign consultants, employers, professional bodies and others, one of the points which emerged clearly was that the present age of entry to polytechnics is low. The consensus was that the entrants to polytechnics should be mature both intellectually and physiologically.

7.12. Taking into consideration various factors, including the structure of school education which differs from State to State, the Committee recommends that the qualification for entry to polytechnics should be raised from SSLC or Matriculation to Higher Secondary, Pre-University, Pre-engineering or equivalent. Such a measure will not only give an opportunity for polytechnics to admit students of greater maturity but also help in revising the curricula of polytechnics so as to make them more purposeful. This measure will substantially cut down the curricular load in the fundamental sciences and mathematics and the time thus saved could be gainfully employed in teaching the applications of science to engineering and technical studies. Otherwise, the only way to improve quality will be to lengthen the period of education in polytechnics which would involve additional financial commitments.

7.13. While recommending higher qualifications for entry into polytechnics the Committee also took into consideration the poor industrial and environmental background of the majority of the students. Further, the Committee found that in West Bengal, Madhya Pradesh and a few other states, a large percentage of students seeking admission to polytechnics in fact posses higher qualification than the SSLC or Matriculation. Therefore, at present, most of the time in the first year of the courses is spent in bringing up the academic level of the students possessing only the SSLC or Matriculation qualification. This not only wastes the valuable time of the majority of the students but also makes them dispirited as they have to repeat the science and mathematics courses which they have already undergone earlier.

7.14. In the course of discussions with the Committee, a majority of the representatives of the professional bodies and employers and others, including some of the foreign consultants, felt that it would be highly desirable to arrange for some sort of pre-entry training. In this respect, the Committee recommends that efforts be made to infuse a vocational bias at the Higher Secondary School level. Further, there are about 350 Industrial Training Institutes and 284 polytechnics in our country, all with fairly good workshop facilities. Selected students interested in joining polytechnics may be assigned to these institutions during the vacations and given a well graded programe of workshop practice and instruction in drawing etc. so that they may be conditioned better for polytechnic education.

7.2. Selection Procedures

7.21. At present it is observed that there are no uniform selection procedures. Selection is based on one or more of the following:

(a) Marks secured in the qualifying examination particularly in subjects like mathematics and science;

(b) Weightage for co-curricular activities;

(c) performance in an interview or personality test;

(d) performance in a common entrance test.

Some respresentatives of industry and professional bodies suggested that the selection for admission to polytechnics should be based on an aptitude test. The Committee, while accepting that the performance in an aptitude test may be one of the criteria for admission to polytechnics, does not favour its wholesale adoption at the present stage. It, however, suggests that a beginning may be made in selected polytechnics (autonomous polytechnics) with a view to developing some standard aptitude test for the selection of students. Later on, such tests, if found successful, may be extended to other polytechnics.

7.22. The Committee recommends that admission to polytechnics should be made on the basis of merit. This may be on the basis of either the relative merit in the last public examination or the performance in the qualifying examination. The Committee also recommends that some weightage should be given for participation in extra-curricular activities like sports, social service etc.

7.3. Guidance and Counselling

7.31. It is very important to realize that our polytechnics have in their charge very young persons. Polytechnics have not only the responsibility for organising education, but also the obligation to consider the student as a person and assist him to proper development—emotional, social and physical.

7.32. Individual students differ from one another in their abilities, attitudes, prejudices, biases, interests, personal characteristics, socio-economic backgrounds and cultural outlook. These individual differences are crucially important to the proper choice of the type of education and to the potentialities of success. But most of the students know very little about themselves or their abilities and potentials and even less about the nature and aims of polytechnic education. Consequently, most students enter polytechnics without the clear aspirations and motivation which can make their studies meaningful and purposeful.

7.33. Coupled with this, our students enter polytechnics at a very immature age. Many, for the first time, enter hostels away from their homes and often encounter a bewildering environment of life and learning. They often get into serious personal problems of financial, emotional and social character and problems of adjustment to the academic and social environment. In order that the student may gain the maximum benefit of his education and life at the polytechnic it is necessary that he is helped to understand his goals, aspirations, and weaknesses and that he is helped to solve his problems for himself.

7.34. It is in this context that well-organised guidance and counselling services could be of immense value in our polytechnics. The Committee notes that, at present, there are no organised Guidance and Counselling Services either in the schools or in the polytechnics and recommends their progressive establishment in the polytechnics in a phased way. To begin with, Guidance and Counselling Centres should be set up on an experimental basis in the autonomous polytechnics. Depending on the experience, the scheme should be extended to cover all the other polytechnics in the course of the next 10 years.

7.35. Each Guidance and Counselling Centre should have a Guidance and Counselling officer of the rank of a professor, assisted by suitable staff. The officer should be professionally qualified with adequate training in education psychology and vocational guidance. The Centre will need to have library facilities and a testing laboratory for assessment and diagnosis of students' abilities and disabilities.

7.4. Information to Prospective Entrants

One of the difficulties faced by students in making a choice in favour of polytechnic education is the lack of information and publicity about the nature and scope of polytechnic courses and the employment opportunities available for diploma holders. Too many youngsters, and their parents, choose institutions and courses on the basis of inadequate information and knowledge. Adequate information about the polytechnics, courses and employment opportunities must be made available in advance to prospective candidates. Hence the Committee recommends that the Directorate or Department in charge of technical education should collect details of the available technician courses and career opportunities and transmit the same to the Directorate of Secondary Education for publicity among the students in Higher Secondary, Pre-University or SSLC classes.

7.5. Hostel and Campus Life

7.51. Most of our polytechnics are situated in industrial and urban areas. This is in the fitness of things, since the effectiveness of polytechnic education rests on close collaboration with industry. Consequently, it becomes necessary to provide adequate hostel facilities for students coming from rural and other areas beyond a reasonable daily travelling distance. The Committee finds that the present position regarding hostel accommodtion is not satisfactory in many polytechnics and recommends that hostel arrangements be made in all polytechnics for at least 50 per cent of the students.

7.52. Moreover, since the students in technical institutions spend longer periods daily in the campus compared to other students, it is desirable that accommodation is available to all polytechnic students who need it, so that they may work with higher efficiency. Hostel life facilitates the frequent exchange of ideas by students among themselves and with their teachers. Provision of adequate hostel accommodation will thus serve as an important measure of quality improvement in technician education.

7.6. Extra-Curricular Activities

7.61. One of the reasons for student unrest and indiscipline is perhaps the lack of interesting, meaningful and creative activities within the campus for students to utilise the free time available. Apart from this aspect, it is absolutely necessary for the total development of students that they should be initiated to extra-curricular activities which inculcate self-discipline, self-reliance, leadership, integrity, co-operation and other qualities. The Committee, therefore, strongly recommends that there should be adequate facilities for the out-door and in-door activities of students. There should be provision for good libraries, attached both to the students' common room and the hostel. Adequate provision should be made for sports, cultural activities, debating clubs, group discussions and other extra curricular activities.

7.62. The Committee feels that educational administrators can get very useful ideas from students in the planning and conduct of educational programmes and recommends that at least the final year students should be associated with and involved in the various advisory bodies of polytechnics, particularly those concerning student discipline, curriculum development etc.

7.7. Scholarships and Financial Assistance

7.71. According to a survey carried out in 1965-66 by the Education Commission. about 55.8 per cent of the parents and guardians of the students were having an income less than Rs. 150/- per month. The majority of students joining polytechnics are from the low income group. Hence there is a need for adequate provision for financial assistance to such students. It was brought to the notice of the Committee that the present practice of paying the entire amount of scholarship in cash to the students leads to many difficulties. There is a tendency for some students to spend the money carelessly; in some cases the parents utilise the money. The Committee is therefore in favour of extending financial assistance by way of free studentships hostel facilities free books and other educational materials etc., rather than through cash allowances or loans. In addition, there should be provision for merit scholarships to attract talented students to polytechnics in adequate numbers.

CHAPTER VIII

8.0. ASSESSMENT AND EVALUATION

8.1. Objectives

8.11. Assessment and evaluation form an integral part of the total educational process. It is essential that, during and at the end of a course of study, both the teacher and the taught should evaluate how far they have succeeded in the attainment of the objectives of teaching and learning. Assessment and evaluation is a continuous activity which should be designed simultaneously with curriculum development.

8.12. A well designed system of assessment and evaluation is a powerful educational device. It serves the following purposes: it indicates what is important in the subject, how the facts, concepts and principles are educated and used in a given situation, and whether the requisite mastery has been achieved by the student in the course, it furnishes some rational basis of judgment of the student's accomplishment and provides a basis for comparing each individual student's attainment with that of the rest of the class; it points to the direction for further learning and serves as a guide to the teacher to evolve effective and suitable teaching methods and techniques; and finally, it indicates whether the objectives of the curriculum have been achieved.

8.2. Defects in the Existing System

8.21. Evaluation of students on the basis of external final examination is in vogue in all the polytechnics. Under this system it often happens that the subject is taught by one person, the question paper is set by another and the student's answer scripts are valued by a third person.

8.22. The teacher at the polytechnic has no direct role in evaluating the student he has taught. The present system exerts a confining influence on teaching and is liable, in any event, to give a false picture of the real achievement of the student.

8.23. The present type of written examinations tempt the student to prepare for the examinations by memorising lecture notes for reproduction in the examination and thus place a premium on note learning. The student is subject to unnecessary stress and fear on the eve of the examinations. The percentage of failure in the system is very high with the result that the student is likely to resort to malpractice to secure a pass.

8.24. Since the goal of the students is to pass the final examination, the teacher in his turn aims to prepare the student for it. He cannot introduce the latest developments in the subject to the students as the examination is restricted to the prescribed syllabus. The present practice of setting question papers and valuation of answer scripts arouses very little interest and enthusiasm to improve the methods of teaching.

8.25. Further, there is a large time-lag of two or three months between the date of examination and the date of declaration of results. During this period, the student is kept waiting and the institutions are precluded from starting the next academic session. If this lag is drastically reduced the institutional facilities could be better utilised.

8.26. Almost everyone—the teachers, students and representatives of industry and business—with whom the Committee had discussions has stated categorically that the present examination system is one of the greatest drags on our efforts to improve technical education.

8.3. Suggested Reform

8.31. Education has a dual role—the dissemination of knowledge by teachers and the assimilation of knowledge by students. This is best served if the teacher simultaneously carries on the tasks of teaching and assessment. Such assessment will clearly reveal to the teacher whether his teaching is effective and whether learning is achieved. Continuous evaluation based on this principle will not only remove the fear-complex in the mind of the student but also motivate him for effective learning. Consequently, the student will find his studies interesting.

8.32. The system of continuous internal assessment and evaluation is superior to the traditional time-test examinations. In the new system the students will consider evaluation as another learning activity. The system allows the student to study his valued answer scripts, to discuss them with his teachers, to seek clarification on the basis of assessment and to obtain guidance for improvement. This would act as an incentive to learning and help the student to plan his studies carefully. The teacher on the other hand would know where he has helped the students to understand and where he has not. This feed back will help him plan effective teaching. The system will take into account such qualities of the student as his initiative, industry and discipline. The system of continuous evaluation is also a means by which the work of the student on the entire syllabus may be judged and not merely his work on part of the syllabus on which an examiner may base his questions.

8.33. The Committee is quite convinced of the efficacy and purposefulness of the system of continuous internal assessment and evaluation. However, it is conscious of the difficulties in the way of implementing this system in our polytechnics immediately and in toto.

8.34. Internal assessment is a continuous process, which means that the final assessment in any subject should be made up of the results of a large number of tests, assignments etc.

Different methods could be used for assessment; these include the following:

(a) Quiz or unannounced tests.
(b) Home assignments.
(c) Periodic tests.
(d) Oral tests.
(e) Project work, term papers.
(f) Participation in seminars and discussions.

Each of these methods is effective in certain situations and not suitable in others. The nature of the subject and the objectives to be realised in the subject will to a great extent determine the methods of assessment. Therefore at the time of curriculum planning itself the methods of assessments suitable for each subject, the relative weightage for the methods and the timing and sequence of their use must be carefully determined. In the light of such consideration and choice of techniques a great amount of planning will have to go into the methods and programme of teaching. The teacher will have to carefully plan and schedule his work of teaching and assessment.

8.35. The success of the system depends on its acceptance by students. Tests, assignments etc. must be framed to enable objectivity in assessment. The student must be briefed clearly and in advance about the programme of assessment, its contents, timing and criteria and the weightages attached to each method of assessment. He should also be allowed to discuss the valuation of his assignments, answer books or other work at every stage and be convinced of its fairness.

8.36. In order to maintain proper standards of assessment, it is necessary that the records of assessment are carefully maintained in detail and made available for scrutiny by the concerned authorities.

8.37. Frequent interchange of views and experience between polytechnics would be very valuable in developing satisfactory methods and techniques of internal assessment and in arriving at acceptable and standard patterns allowing necessary flexibility to suit the different subjects and methods of instruction.

8.38. Internal assessment calls for a great deal of planning and time-consuming work by the teachers concerned and this fact must be taken into account in determining the work loads of teachers. In the initial stages the teachers may experience some difficulties in carrying out internal assessment. They will require some training in the methodology, objectives and techniques of assessment and the preparation of test materials.

8.39. Taking into consideration the initial difficulties, the Committee feels that it would be advisable to start with a mixed evaluation system consisting of continuous internal assessment carrying equal weightage with the external examination. This should however be a transitory arrangement.

8.4. Implementation of the Reform

8.41. The Committee recommends that the system of annual final examinations should ultimately be replaced in all polytechnics by the system of continuous internal assessment. The proposed reform should be introduced as suggested below.

8.42. Proposals have been made earlier in this report for constituting a State Council of Technical Awards and for the phased selection of polytechnics for the grant of autonomy. The autonomous polytechnics may institute their own system of internal assessment and evaluation. They will however be required to submit their scheme of assessment and evaluation, as well as the names of external examiners proposed to be appointed, to the Council for approval. The Council will have powers to call for the question papers and other relevant records of assessment to satisfy itself that the requisite standards are maintained.

8.43. In respect of non-autonomous polytechnics, for the time being, external examinations may continue to the extent of 50 per cent of the total assessment. These examinations will be conducted by the State Council of Technical Awards. The remaining 50 per cent of the total marks should be awarded on the basis of continuous internal assessment by the polytechnics themselves. The internal assignments, periodic tests etc.

8.44. The State Council of Technical Awards should continuously review the methods of internal assessment and devaluation and suggest necessary improvements.

8.45. Courses in the methods of assessment, evaluation and grading should be arranged for teachers in the form of short training programmes and summer courses.

8.46. The complete change-over to the system of continuous internal assessment and evaluation should be effected in all polytechnics within a period of 10 years.

CHAPTER IX

9.0. TRAINING AND EMPLOYMENT

9.1. Education and Training

9.11. In the earlier chapters, the terms 'education' and 'training' have been used synonymously to denote the total process of preparing students for technician functions. In a strict sense, education means a relatively open-ended process: it produces a state of mind in which further development can occur. Training is a relatively closed process in the sense that it has a definite end at a given level of skills. To be clear about these distinctions, the terms 'education' and 'training' are being used in this chapter to comprise the two parts of the total process of technician education.

9.2. Training Needs of Technician Education

9.21. Any type of education implies some training. The relative proportion and type of training in the overall education depends on the type and level of education.

9.22. It is obvious that in any education intended for a profession or a vocation, the training content will normally be greater than in liberal or general education. The amount and kind of training will also depend on whether the kinds of skills to be imparted are manual, mental, conceptual or creative. To arrive at the quantum and kind of training needed in the education of a technician, one has to take into account the nature and level of his work.

9.23. It is the job of a technician to interpret and work out the details of plans, designs or programmes, to determine the techniques to be used and to choose the tools, machines, processes and procedures best suited for the job. In doing so, he is required to exercise judgment in the sense of diagnosis, appraisal and initiative.

In most cases, technicians will have to supervise the work of skilled craftsmen. Therefore, they must be conversant with the skills and aware of the nature and problems of the work of skilled craftsmen.

9.24. The technician thus combines specialist knowledge, experience and skill with the ability to apply them. The special characteristics of his work must determine the nature of his education. Therefore, the technician courses should be so organised as to comprise the following five elements:

(i) basic and applied sciences (theory)
(ii) basic and applied sciences (practical)
(iii) technology (theory)
(iv) technology (practical)
(v) general education

Frequently, in discussion, these five elements are coalesced to form two, *viz.*, 'academic education' and 'practical training'. Whilst the boundary between the two is not well defied, 'education' can be considered to embrace (i), (iii), (v), and commonly part of (ii), while 'training' consists of (iv) and the rest of (ii). Technology (practical) consists of institutional training backed by adequate industrial training.

9.25. Practical training is thus an integral part of the education of technicians and the success of technician education programmes will depend on the degree to which academic education is integrated with, or supplemented by, relevant practical training. It is also clear that the training should closely reflect actual technician work.

Practical training should not be confused with the practical work that must be carried out along with the theoretical studies. Academic education is concerned essentially with providing the knowledge of why a job is done in certain ways; practical training is concerned with how the job is done and with the acquisition of specific industrial skills. Its main objective is to relate theoretical knowledge to actual practice in the industry.

9.26. A training programme should introduce the potential technician to a variety of operational problems obtaining in the practice of his occupation, whether these relate to the selection of operational procedures, manufacturing processes, machines, materials and methods, or to the ensuring of control of production sequences, quality and cost. It should also expose him to conditions of work involving, among other things, organisational procedure, group activities, human relations and production economics.

9.27. Practical training must aim to provide the student with an understanding and appreciation of the following:

(a) The potentialities and limitations of basic workshop processes;

(b) The properties of materials used in engineering workshops;

(c) The role of the technician in industry, and the significance of the abilities and skills demanded of other persons engaged in the same industry;

(d) The general principles of organisation and management.

A sound practical training will inculcate a respect for the value of actual practical work. By such training the individual should come to realise his own limitations and potentialities and gain confidence by developing his interests and aptitudes. It should aid his growth not only as a technician but also as a person, and enable him better to make his unique contribution to industrial society.

9.3. Phases and Contents of Practical Training in Industry

9.31. The specific contents of practical training schemes for technicians will vary greatly owing to the many different types of tehnicians found throughout industry. Commonly, however, any training scheme can be split up into three phases, namely, induction, basic training and secondary training.

9.32. All training should begin with a short induction period designed to give the student an introduction to an industry or establishment of the type in which he would get his further training. This should preferably be arranged in an industry or firm. Where this is not possible, the training officer can organise an induction programme in the institution itself.

9.33. Basic Training

The aim of basic training is to impart the necessary fundamental skills, such as the basic workshop skills, so as to lay the foundation for the later shop floor or field experience. Basic training should normally be provided by the Polytechnics themselves. (For this reason, basic training has been discussed under workshop practice in para. 5.46). In this context the Committee recommends that, besides strengthening the existing workshop facilities in polytechnics, wherever possible, closer links should be established between polytechnics and Industrial Training Institutes. Some firms possess excellent apprenticeship centres or training workshops, and in such cases, basic training may take place in the actual factory.

9.34. Secondary Training

This phase should have as its object a broadening of technical knowledge and the gaining of insight into some of the workings and problems of industry in general. In the later stages, the training should be more specifically related to the actual work on which the technician will be engaged when he has finished his training. For example, for mechanical engineering technicians, this phase should include more advanced work on tools and workshop processes as they are related to some of the operations among Component manufacture and inspection; Assembly; Plant erection, installation and test; Operation and Maintenance; and Design, drawing and development with accent on detailing. Project work should be encouraged during the period of training. Arrangements should be made for senior staff of the industry to lecture and explain the practices.

While some aspects of secondary training, particularly design, drawing and detailing, can be organised in the institutions themselves, the major part of secondary training could only be imparted in the production shops, process control departments testing laboratories and technical offices of industrial units and commercial firms.

In the case of sandwich courses, part-time courses, and diversified courses it will be essential to integrate and match the institutional programme and industrial training so that education and training may complement each other.

During the periods of training in the industry, it is most important that apprentices should carry out the actual operations themselves, so as to extend and develop the skills and knowledge they have acquired during the basic training period, and to become aware of the procedures and practices which are part of the technician's sphere of work as well as to come into contact with problems associated with management, labour and industrial relations. The importance of making decisions, giving clear instructions, preparing reports and similar activities should also be stressed in the training.

9.4. Principles of Training

9.41. Training must be made an interesting and challenging experience and must encourage the student technicians to use their initiative and persistence in understanding and solving problems themselves. The practice of learning by observation should be kept to an absolute minimum.

9.42. Assignment of specific work involving some degree of responsibility and its proper planning and supervision should constitute the basis of practical training in any establishment. Personal or group projects or assignments should be introduced wherever possible.

9.5. Assessment and Evaluation of Training

9.51. Training must be assessed and evaluated. It should preferably have adequate weightage in the total evaluation. There is a need to devise adequate scientific methods to assess the results of training and evaluate the degree to which the objectives of training have been realized.

9.6. Training Facilities—Present and Future

9.61. The present position regarding training in industry is quite unsatisfactory. Training under the Stipendiary Training Scheme is available to very few students. A few other students manage to get some sort of training placement largely on their own initiative. Such training is neither planned to specifically meet the objectives of any diploma programme, nor organised and supervised properly by either the institution or the industry. Very often, the trainee is largely left to himself to move around and pick up whatever knowledge he could, so long as he does not hamper the routine activities in the industry. Certain large organisations do organise training programmes for new recruits but this training is in the nature of job-orientation, being solely governed by job considerations rather than by the educational objectives of technician training. It should, therefore, be the endeavour of all concerned to make arrangements to provide well-organised and supervised practical training in industry for all diploma students during vacations and/or after the completion of course. Since several departments such as industries, labour and technical education are administering several kinds of training programmes, an effective coordination of their efforts should be brought about.

9.62. It was brought to the notice of the Committee by representatives of industry that the facilities presently available in industry are inadequate to provide training places to all graduates and diploma holders coming out of technical institutions. The recent recession in the economy and the growing unemployment among engineers have added to the difficulty in finding training opportunities for diploma holders. The Committee notes in this context that, in countries such as Britain and West Germany, attempts are being made to provide the much needed practical training by setting up industrial training centres with simulated production conditions. Keeping in view the important need to ensure practical training to all students in polytechnics and the practical difficulties obtaining in industry, the Committee recommends that production-cum-training centres may be set up at places wherever two or more polytechnics are situated. The facilities available at these centres should also be used for providing training during vacations or after the diploma courses. The centres could also provide practical training to students of polytechnics in rural areas where industries do not exist.

9.63. Training forms an integral part of technician education. Planning and organising suitable training programmes and coordinating them with the requirements of different technician courses in cooperation with industry, constitute an important facet of the work of polytechnics. This imposes heavy responsibilities on the polytechnics and calls for the services of a full-time training officer with considerable industrial background and contacts. Such an officer would, moreover, be able to guide and assist students in finding suitable employment and help employers to recruit suitable technicians. The Committee, therefore, strongly recommends the setting up of a separate training and placement in each polytechnic manned by an experienced training and placement officer of the rank of a professor, with suitable assistance.

9.64. Finally the Committee is of the firm view that if any training scheme is to be effective, whether it be in industry, in the production-cum-training centres, or in the Industrial Training Institutes, it is absolutely necessary to set up training departments in these organisations manned by capable executives who could work in close collaboration with Principals, Heads of Departments and Training Officers of the Polytechnics.

CHAPTER X

10.0. Partnership with Industry and Commerce

10.01. Unlike the other streams of higher education, the education of technicians is primarily governed by the needs of industry and commerce. Moreover, the very nature of technician training and the limitations of institutions with regard to training facilities, require that industry and commerce should assume the responsibility for giving a part of the training for which they are best equipped. For these reasons, technician education needs to be regarded as a venture in partnership between educational institutions on the one hand and industry and commerce on the other. In this process, both have common interests and concerns to share. The problems facing technicians, the problem of industrial productivity, the gap between educational objectives and industrial requirements and the challenge of rapid advances in science and technology are all but a few examples of such common interests. In the reorganisation of polytechnic education, the Committee would stress the need for both of them to come closer.

10.02. At present, the partnership of industry in technician education is mostly confined to participation in higher level policy making by way of the association of a few experts from industry in the All India Council for Technical Education and its Regional Committees, and in the bodies at the State level concerned with technician education policy. At the unit level barring a few instances of the collaboration of industry in running sandwich courses, or in offering training facilities for students, there is little evidence of partnership. This, however, is not surprising because, at the unit level, there is in fact very little opportunity or incentive for establishing close partnership.

The individual polytechnics have very little authority or control over the planning and organisation of technician education and therefore the question of their forging links with local industries hardly arises.

10.03. The Committee is convinced that the collaboration of industry in the education of technicians will be real and effective only if it exists at all levels of the Polytechnic education system from the national to the unit level. At the national regional and state levels the partnership should be made more effective than hitherto. It is at the unit level however that there is the greatest need for the most active collaboration. The association of industry with the proposed State Councils of Technical Awards and with the autonomous polytechnics in framing and changing polytechnic courses will form a very important aspect of the collaboration. Conditions must moreover, be created which favour the establishment of close collaboration in other aspects, particularly in the implementation of the programmes of education and training. The specific areas and aspects of partnership as implied in the Committee's recommendations for the reorganisation and improvement of polytechnic education are briefly considered below.

10.1. Cooperation of Industry and Commerce in the Educational Process.

10.11. Industry and commerce, being the largest consumers of the products of Polytechnics have the responsibility to specify the nature and quality of the products to be turned out from polytechnics. This calls for closer collaboration and cooperation of industry and commerce in the planning and development of educational programmes and the provision of facilities for training.

10.12. It has already been emphasised that training is an essential part of technician education. Executive training cannot be achieved without the active and whole hearted participation of industry. It will therefore be necessary for industrial establishments to determine the availability of proper training facilities with reference to the number of training places, types of facilities and training personnel. It is also necessary for them to determine whether they will be able to offer appropriate facilities for running sandwich courses. Once this point is made clear, the polytechnics should work out the educational and training programmes with the assistance of industry. Similarly in the case of diversified and special courses industry should take the initiative to collaborate with the polytechnics in identifying the areas and fields in which courses are needed and in designing the appropriate courses. Industry should also assist polytechnics in the planning, implementation and supervision of training programmes for students after they have completed their institutional education.

10.2. Industrial Training for Teachers

10.21. It has been stressed earlier that polytechnic teachers should be familiar with the working practices and trends of industry and be able to give an industrial orientation to teaching. This is a matter on which both the polytechnics and industry should be vitally concerned. It is therefore recommended that industries should extend their fullest cooperation in providing the much needed industrial experience to polytechnic teachers either by short-term or long-term training or through other arrangements.

10.3. Research and Development

10.31. One of the areas of fruitful collaboration between industry and polytechnics is in the area of research, design and development. The Committee recommends that industries in the neighbourhood of polytechnics must be encouraged to refer their research, development and production problems to the polytechnics. Industries may also support other research or development projects undertaken by polytechnics.

10.4. **Industrial Orientation to Teaching**

10.41. The above measures will enable teachers t perceive actual industrial and field problems and suitably use them for class room or laboratory work Close contact of teachers with industry will moreover help in planning project work based on the actual problems and practice in industry and commerce. In addition, the Committee recommends that experts from industry should be invited to discuss some typical problems of the shop floor and explain through special lectures and seminars how they are solved. Such lectures and seminars are among the best ways of integrating industrial experience and polytechnic education, and can contribute greatly to motivate students towards a practical way of thinking.

10.5. **Manpowers Forecasting and Planning**

10.51. The Committee has recommended earlier that special units should be set up in the Directorates or Departments in charge of Technical Education for the estimation of future technician demand, speciality-wise, on the basis of analysis of occupations. Industrial collaboration is essential in such an activity; it is therefore recommended that industry and commerce and their federations should be fully involved in the work of these units. In this respect, cooperation with the Industrial Liaison Boards, wherever these are established, will be fruitful.

CHAPTER XI

11.0. STATUS AND PROFESSIONAL DEVELOPMENT OF TECHNICIANS

11.1. Role and Status of Technicians

11.11. The rapid pace of technological development and its increasing adoption by industry have led to a growing complexity of industrial activity. As new materials and new industrial processes emerge, the problem of manufacturing products characterized by greater reliability and improved performance becomes increasingly difficult. Simultaneously, industry and commerce are confronted with the problem of providing high quality products at competitive prices in the face of the continually rising costs of both material and labour. Industry and commerce can meet these challenges only if they make the most efficient use of manpower at all levels. This means that the several middle level functions in industry relating to the details of design, drafting, production quality control, supervision, maintenance, sales and servicing have to be performed by persons specifically trained for such jobs, leaving only the more advanced and creative work in management, innovation, research, design and development to the engineers, scientists and professionals. Craftsman level experience is quite inadequate to meet the requirements of the middle level functions. Herein lies the importance of recognizing technicians as a very important and separate entity with distinct functions and clearly identified requirements of knowledge and skills. It is essential to realize, moreover, that these requirements call for an education and training quite distinct in nature, contents and approach from that of engineers or craftsmen.

11.12. In this context, the supply of adequate numbers of properly educated technicians will largely depend on the status accorded to them appropriate to their qualifications, and their role and importance in industry. The capability of polytechnics to attract talented students in sufficient numbers, the motivation and performance of students, the dedication and effectiveness of teachers, the image of the polytechnics in society and consequently the resources they will command—are all greatly influenced by the status of technicians in society and industry.

11.13. Status is a complex concept involving several factors, the most important of which are: attitude of and recognition by, society and industry, economic incentives, promotional opportunities and scope for personal growth and development. The traditional attitude of society to regard work-oriented education as of a lower kind compared to the more glamorous intellectual pursuits underlying university education, and society's lack of appreciation of the dignity of labour, need to be reversed if technician education is to claim its rightful place in society in the context of economic development. While this is a social problem, the solution of which lies in a change in the attitudes and beliefs of society as a whole, much positive action can be undertaken to accelerate and aid this change. The Committee commends the following steps to ensure the proper status for technicians :

(i) Industry and commerce should rationalize their manpower structure and identify specific technician functions. They must appreciate the role of technicians in the complex of industrial and commercial occupations and accord a recognizable career structure adequately reflecting the importance of their position. Formal technician qualifications should be insisted upon for recruitment. The Survey of Industries by the Committee shows that at present only 36 per cent of technician posts in industry are held by diploma holders, the rest being held by degree holders (16 per cent) and those with craftsmen level experience (48 per cent). It is obvious that a majority of the industries are yet to clearly appreciate and recognise the separate identity of technicians with reference to their work and educational requirements. It is essential that graduates should not be employed as technicians except to the extent necessary to give them job-training. Engineers should also appreciate the role of the technician in the technical team. Where craftsmen are promoted, industry should see to it that they receive the necessary education at the polytechnics.

(ii) Technician courses must have an integrity of their own; they must meet the specific needs of technician functions in industry and commerce. The courses must be framed in consultation and cooperation with industry.

(iii) Technician courses should not lead the technicians to a dead end. They must therefore, be broad-based to facilitate further studies.

(iv) Polytechnics should organise a variety of updating, refresher and extension courses including short-term and advanced-diploma courses for technicians in service. They may also eventually organise part-time degree courses. Through these courses, technicians should be enabled to qualify for higher positions and promotions. Industries must encourage the development of their technicians and offer better promotion opportunities to those who improve their qualifications through these courses.

(v) The image of polytechnics as centres of career education should be promoted through the development and organisation of new courses and experimentation with educational programmes. For this purpose, polytechnics should have the flexibility and freedom to develop in new directions and explore new horizons. In this context, the Committee stresses the important and valuable role of the proposed State Councils of Technical Awards as a means to ensure the academic freedom of polytechnics and to guide their development and safeguard the necessary standards. The awards of the Councils will not only set the seal of standard and quality on the products of polytechnics but also enhance their recognition and acceptability, by virtue of the close association of industry and commerce in the work of the Councils.

(vi) Universities, technological institutions and polytechnics should establish closer rapport and understanding and work as partners in education. They should take positive steps to remove, from the minds of the student community and others, the prevailing tendency to regard vocational and work-oriented education as inferior to university education. Students must be made to appreciate that different types and patterns of education are but different means to meet the present and future educational and manpower needs of society and industry. To this end, college and university professors and administrators should try to associate themselves with polytechnic education.

11.2. Development of Professionalism Among Technicians

11.21. The question of the status of technicians is closely related to the development of a sense of professionalism among them.

11.22. A professional person is one who applies certain knowledge and skills, usually obtained by education and training, for the service of society. In addition, a professional person observes an acceptable code of conduct, uses discretion and judgment in dealing with people, and respects their confidence.

11.23. Professionalism is not inherent in a person's nature. Like technical skills, it has to be acquired. A person does not become a professional immediately upon completion of his formal education. He can be introduced to such concepts during his study but he has to widen his outlook by contacts with professional bodies. Each technician should recognize the need to join professional societies.

11.34. A professional body would provide technicians an organised forum for discussing common problems and articulating their needs and aspirations, besides giving them a sense of belonging to a group which has an ethos of its own and an influential voice on all matters connected with the development of technicians and their education and training. It would thus help to maintain and enhance the standing of technicians and greatly contribute to the recognition of technicians by society.

11.25. By and large, technicians are at present yet to develop a sense of professionalism or an awareness of their own distinct identity in industry as a group of people with specifiic roles in much the same way as engineers. Opportunities for their responsible association and participation with professional bodies are largely non-existent. For example, at present, diploma holders are eligible to enrol themselves only as student members of professional bodies such as the Institution of Engineers (India).

11.26. The Committee feels that technicians should have an organised forum which will enhance their status and enable them to contribute effectively to increased productivity and to the development of technician education and training. A separate professional body or association of technicians may not be viable or effective at present. Therefore, the Committee favours their association in a responsible way with the several professional bodies and other organisations representing industrial and commercial interests. The Government should take the initiative in persuading the professional bodies and other organisations and associations concerned with technical education, training, industrial and commercial interests etc. to set up technician sections/technician education and training sub-committees etc. in which the teachers of polytechnics should also be involved. Some of these bodies and associations are listed in Annexure 11.1 to this chapter.

ANNEXURE 11.1

LIST OF PROFESSIONAL BODIES AND OTHER ORGANISATIONS*

1. Indian Society for Technical Education, New Delhi.
2. Institution of Engineers (India), Calcutta-20.
3. All India Manufacturers Organisation, Bombay.
4. Indian Engineering Association, Calcutta.
5. All India Management Association, New Delhi-13.
6. National Productivity Council, New Delhi.
7. Federation of Indian Chambers of Commerce and Industry, New Delhi.
8. Institute of Chartered Accountants of India, New Delhi.
9. Institute of Indian Foundry Men, Calcutta-20.
10. Indian Institute of Chemical Engineers, Calcutta-32.
11. The Institution of Telecommunication Engineers, New Delhi.
12. The Textile Association (India), Ahmedabad.
13. Indian Society of Agricultural Engineers, New Delhi.
14. The Aeronautical Society of India, New Delhi-1.

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*NOTE: The list is not exhaustive.

CHAPTER XII

12.0. Administration, Finance Control and Inspection

12.01. Organisation of technical education is complex and involves considerable financial outlays and expenditure. In view of this, judicious administrative control is necessary to make the best use of all available resources. This, in turn calls for firm Central policy-making and planning and also implies consultation and liaison on a continuing basis among a wide group of individuals and organisations. Effective co-ordination at the national level is therefore absolutely necessary.

12.02. The seventh schedule, Union list I entry 66 under Article 246 of the Indian Constitution envisages that in the matter of coordination and determination of standards in institutions for higher education on research and scientific and technical institutions, Parliament has exclusive power to make laws. This, in turn, puts the major responsibility for the proper development of technical education on the Central Government. It follows that there should be a strong machinery at the Centre for discharging its Constitutional obligations and responsibilities in Central policy-making and planning in respect of technician education. This involves continuous study and evaluation of schemes connected with the development of technician education, and consultation and liaison with industry, technical organisations, State Governments etc. in order to ensure that the facilities created in the country are properly utilised according to the manpower requirements of the country as a whole. In this context, the Committee recommends that adequate provision should be made to strengthen the present administrative machinery at the centre *i.e.* the Ministry of Education, for the effective discharge of its responsibilities.

12.03. Technician education cannot be planned on a rigid basis. Flexibility in planning is essential in order that the education may continuously answer the demands and changing needs of local industries and other organisations absorbing technician manpower. There is no doubt that, for planning technical education, a strong national policy is necessary: but such a policy should be flexible enough to permit modification according to the peculiar regional or local needs with reference to the type and level of technicians. Mobility of technicians is another factor which calls for the formulation of Regional and State policies within the overall frame-work of the national policy and plans.

12.04. Considering all these aspects, and in the best interests of the country, the responsibility for the administration and control of technician education should be shared appropriately by bodies at the Central, Regional, State and Unit levels. The responsibilities at each administrative level should be properly defined. The Committee's view on the pattern of administration and allocation of functions and responsibilities at the different levels are discussed below and indicated in the charts in Annexures 12.1 and 12.2 to this chapter.

12.1. National Level

12.11. The formulation of general national policy and the planning, coordination and determination of standards of technician education should rest with the Central Government. Otherwise, a variety of policies may be imposed from various organisations and States which may ultimately be unsuited to the national economy and the needs of industries. In this respect, the All India Council for Technical Education and its Committees and Boards should continue to act as the advisory machinery to the Government. However, in order to make it more effective, it may be necessary to reorganise the Boards of studies of the All India Council for Technical Education. At present, there is no separate Board of Studies or Committee for technician education. Technician education is being dealt with by the different Boards of Studies of the AICTE dealing with the different aspects of engineering and technology. It is recommended that a separate Committee on Technician Education and Training may be constituted under the auspices of the All India Council for Technical Education to deal with all aspects of technician education and training at the national level.

12.12. In order to give efficient secretariat help to the Committee proposed above, a separate unit may be created in the Ministry of Education. This unit should also serve as an effective medium for the collection and dissemination of information connected with technician education. It should undertake studies on manpower requirements at the national level including job analysis etc., with reference to educational preparation. It should also collect and analyse information regarding the direction of changes in technology and industrial development in the country and the changes taking place in technician education abroad.

12.2. Regional Level

12.21. The All India Council for Technical Education has to keep in close touch with the States formulate national policies and plans with due regard to the regional needs and check the haphazard growth of technician education. In this respect the Regional Committees of the AICTE and the regional organisations of the Central Government may have to be reorganised keeping in view their overall responsibility in the administration of technician education *vis-a-vis* those of the Central and State organisations. The Regional authorities should maintain constant touch with the industries, technical institutions and State Governments located in the region and help to bring about a balanced develepment of technician education in the region according to the demands and needs of the economy and industry. The regional organisations should act as a forum for the exchange of ideas and experiences among the States located in the region.

12.3. **State Level**

12.31. The Committee recommends that detailed studies of manpower demands in the State, training in industry, programmes of development, teacher development and administration of polytechnics with respect to financial control and coordination at State level, should be the direct responsibility of the State Government so that programmes and schemes may be effectively implemented. The State Governments should constitute a separate authority, *i.e.*, the State Council of Technical Awards (SCTA) to be responsible for control and supervision over all academic matters, including approval and development of curricular and academic programmes, co-ordination and maintenance of standards etc. The State Governments may also authorise the SCTA to advise them on various aspects of technician education both academic as well as administrative. The role and functioning of the State Council of Technical Awards have been discussed in detail in Chapter V, para 5.72.

12.4. **Unit Level**

12.41. In view of the special need for the growth of technician education, it is felt that unless administration and control are decentralised and more autonomy is given to individual institutions, it may not be possible to stimulate the healthy growth of polytechnic education. Therefore it is necessary to delegate sufficient administrative control to the unit level. This has already been discussed in detail under the autonomous institutions (para 5.71). It should be the endeavour of all that, as far as possible, the academic responsibilities and general day-to-day administration should gradually be delegated to the polytechnics authorities. There should be adequate delegation of financial power to the Heads of Polytechnics to function efficiently. This will not only help involve the faculty and administrative authorities of polytechnics in the development of technician education but also make them responsible for the proper implementation of schemes.

12.5. **Industry Level**

12.51. Apart from the division of responsibilities between the Central and State Governments, there should be some division of responsibilities between the Governments and the industry in the administration and control of technician education. Although the main responsibility to provide the basic technical education at various levels rests with the governments, it is for the industry to build up on this, the training and specialisation it needs. What is needed is a strong partnership and cooperative effort in which the basic and theoretical education are provided through institutional efforts and the practical training and expertise are available through industry. The industry should be involved completely in the control and administration of technician education, as far as possible at all levels, through the medium of the All India Council for Technical Education, its Regional Committees, the State Councils of Technical Awards and the Advisory Committees of various polytechnics etc.

12.6. **Finance**

12.61. As regards the financing of polytechnic education the Government has to take the major responsibility both at the Central and State level but industry should also be a party to the financing as it directly benefits from it. This can be achieved through voluntary efforts. Selected industrial establishments may be persuaded to contribute the necessary funds and facilities for the development of sandwich courses, special types of short-term or extension courses etc. So far as new experiments and innovations in technician education are concerned, the Central Government should take the entire financial responsibility by sponsoring pilot project and other programmes.

12.7. **Evaluation**

12.71. Academic evaluation at the State level has been dealt with in detail under the State Council of Technical Awards. At the National level, adequate provision should be made for the evaluation of the entire system to ensure that the money spent is effectively and properly utilised and that proper standards are maintained with regard to the overall national needs. Without a proper feed-back system, it may be difficult to formulate worth-while national policies or plans to serve the needs of the national economy.

12.8. **Cost Analysis**

12.81. As the cost of establishment and maintenance of a polytechnic depends on various factors such as field of studies, type and contents of courses and student strength, it is extremely difficult to give any probable cost analysis for establishing a polytechnic. Therefore the Committee has not attempted to give any analysis of capital costs. It is suggested that whenever a new polytechnic or a new technician course is started the administrative authority concerned should appoint an expert committee with representatives of the concerned industry and faculty to work out the cost of the project.

12.82. An analysis of the present expenditure pattern in a polytechnic shows that about 85 per cent of the total recurring expenditure is incurred on the wage bill. Only the remaining 15 per cent which works out to Rs. 120 per student per year, is left for other expenses including consumable stores. This amount is grossly inadequate even to meet the ependiture in providing effective training to students, not to mention the other items of maintenance expenditure. Therefore it is imperative that the annual provision under contingencies, materials etc. should be raised to a minimum of Rs. 300 per student against the provision of Rs. 120 to Rs. 150.

If the recommendations of the Committee made under various chapters are accepted, the annual per capita expenditure (recurring expenditure) may have to be revised to a figure of Rs. 1,700 to Rs. 1,800 The basis on which this figure has been worked out is given in Annexure 12.3 to this chapter.

ANNEXURE 12.1

PATTERN OF ADMINISTRATION

Government of India	Central finance, Job analysis, Manpower estimates, Control of available placement and training facilities.
All India Council for Technical Education, Committee on Technician Education and Training	Coordinating body for inter-State matters, consideration of finance from centre.
Regional Committee	Body for coordination between States in the Region.
State Government **Directors of Technical Education State Board of Technical Education**	Job analysis, Manpower study, Development planning, Financed from the State.
State Council of Technical Awards (SCTA)*	Independent autonomous body for Control Inspection, Approval, and Maintenance of Quality and Standards and Award of Diplomas; Other advisory functions.
POLYTECHNICS **Governing Body** **Academic Board**	Autonomous with respect to curriculum framing assessment, academic experimentation and development programmes.

*NOTE :

The SCTA is not an examining body to determine and impose syllabuses on the polytechnics or to set examinations; the polytechnics themselves are to be given the responsibility of constructing curricula and conducting examinations. The SCTA is an inspecting and supervising body which works through subject panels, tanding committees and visiting commissions appointed by it.

ANNEXURE 12.2

ALLOCATION OF FUNCTIONS AND RESPONSIBILITIES

Level of Administration	Advisory Bodies and A
Central and Regional Levels	
1. Overall planning of techcal education vis-a-vis Five Year Plans and perspective plans.	All India Council for Technical Education/Committee on Technician Education and Training/Regional Committees. Ministry of Education/Regional Offices.
2. National policies and objectives with reference to coordination of standards foreign aid etc.	
3. Sharing of financial costs.	
4. National manpower needs	
State Level	
1. Programmes of development, Detailed manpower needs; Approval and development of curricular and academic programmes Teacher development ; Training in industry.	State Board of Technical Education/State Council of Technical Awards (The State Director of Technical Education is to be the Member-Secretary). (The State Government to determine the manner and method of setting up the SCTA and specify its relationship to the State Board of Technical Education.)
2. Administration of Polytechnics Financing. Coordination of standards at State level.	
Institution Level	
(a) Autonomous Polytechnics	Governing Council Academic Board.
1. Day to day administration.	
2. Planning and organization of academic programmes and training industry.	
3. Implementation of academic programmes and training	
(b) Non-Autonomous Polytechnics	Directorate of Technical Education/Governing body.
1. Day to day administration.	
2. Implementation of academic programmes and training.	

ANNEXURE 12.3

Estimated Annual Recurring Expenditure for a Polytechnic

A tentative estimate of the annual recurring expenditure on the running of a polytechnic with an intake capacity of 180 per year has been worked out here based on certain assumptions. It is realized that various factors including the strength of the polytechnic and the number, type and pattern of courses, affect the annual total, as well as per capita, recurring expenditure. Expenditure on experimental projects and other special programmes of quality improvement, training etc. has been excluded. The estimate is therefore to be regarded only as a broad guidance for working out the annual recurring expenditure.

The strength of the polytechnic is assumed to be about 500 to 550 which generally is the case with most of our polytechnics at present. However, the optimum strength of polytechnics could well be of the order of 1,200 to 1800 students, without substantial additional capital outlays.

For purposes of the estimate it has been assumed that the polytechnic offers a total of five courses (including general and diversified courses).

In making the estimate the recommendations made earlier regarding teacher-student ratio and staff pattern have been kept in mind. Accordingly a teacher-student ratio of about 1:12 and a senior to junior teaching staff ratio of approximately 50:50 have been assumed. Also, provision has been made for a training and placement department, better library-staff and for increased laboratory and office assistance.

Due provision has been made for regular additions to the library (*vide* the Committee's suggestions in Annexure 5.5) and for increased expenditure on maintenance, consumable and materials necessary to ensure effective laboratory and workshop training. With regard to the latter, the Committee has recommended earlier [para 5.47 (f)] that a minimum of Rs. 300/- per student should be provided in the annual budget.

Salaries have generally been assumed to be at par with the scales of pay applicable to engineering colleges.

Extra expenditure will have to be allowed if the courses are conducted on the sandwich pattern. In this regard the Ministry of Education (*vide* D.O. No. 3-5/70 T. 3, dated 4th May 1970 of the Joint Educational Adviser (T)) has already initiated a programme in which an allowance of Rs. 150/- p.m. per student is made for a 12 month period for each sandwich course student. This has not been included in the estimate.

Items of Expenditure	Amount per annum	Total
	Rs.	Rs.
SALARIES AND WAGES		
Principal (1)	18,000	..
Professors(3)	45,000	..
Assistant Professors(9)	1,08,000	..
Lecturers (12)	1,15,000	..
Associate Lecturers (16)	1,25,000	..
Workshop Instructors/Demonstrators/Lab. Assistants/Draftsman/Lab. Technicians	60,000	..
Office Staff (including P.A., Superintendent, Assistants)	50,000	..
Skilled workers	35,000	..
Unskilled workers, Attenders, Watch & Ward.	32,000	..
Librarian (1)	10,000	..
Library Assistants (including an Assistant Librarian)	12,000	..
Training & Placement Officer with an Assistant.	20,000	..
Physical Education Director (including attenders)	10,000	..
Provision for Provident Fund etc. @6¼%	45,000	..
Total Salaries and Wages. . .		6,85,000
MAINTENANCE AND MATERIALS		
Library additions (Books and Journals) .	25,000	..
Equipment modernizing and replacement @ 5% of capital value (approx.) . .	50,000	..
Maintenance including workshop and laboratory consumables, materials and contingencies @ Rs. 300 per student. .	1,50,000	..
Total Maintenance and Materials .		2,25,000
Total Annual Recurring Expenditure		9,10,000

Annual Recurring Expenditure per student	1,820

In the case of larger polytechnics, provision must also be made for setting up a Guidance and Counselling Department as recommended in Chapter VII. The annual expenditure on this account will be of the order of Rs. 20,000/-.

CHAPTER XIII

13.0. PLAN OF ACTION

13.01. In this chapter some of the lines on which action needs to be taken for implementing the recommendations of the Committee on the reorganisation and development of polytechnic education are considered. Such action is required at the planning, decision-making and implementation levels involving not only the Central and State Governments but also industry and, more importantly, the polytechnics themselves.

13.1. Technician Manpower Estimates and Surveys

13.11. It is observed that, notwithstanding the provisions made in the Second and Third Five Year Plans, for such quality improvement programmes as increased hostels, staff quarters and teacher training and refresher courses, the demand for more institutions and additional admission capacity in polytechnics has had a higher priority in the Annual Plans of the State Governments often at the cost of the much-needed improvement and consolidation of polytechnic education.

13.12. The Committee noted in this context that, according to some recent estimates, made by the Institute of Applied Manpower Research, of the probable demand for technicians during the Fourth and Fifth plans, the overall facilities at present created in the polytechnics would, by and large, be sufficient to meet the future requirements; what is required is the careful planning of speciality-wise admission taking into account the nature and type of technician requirements in local industries. The Committee is of the considered view that at least for the next five years, there is no need to start any new polytechnic. The existing intake capacity in polytechnics is adequate to meet the demands for technicians in the next three years. Thereafter the position may be reviewed and the intake may be changed to meet the actual needs. Meanwhile, concentrated attention has to be given to the question of reorganisation and modernisation of the existing polytechnics.

13.13. Efforts should be made immediately to make reliable estimates of the demand for technicians for the Fifth and Sixth Plan periods. These need to be undertaken at least on a regional basis, if not by the States, and in terms of the different types of technicians, branches of engineering and specialisation and their distribution according to industry, commercial organisations, public utilities and other sectors of employment. The Central Government should sponsor these studies to be undertaken by institutes like the Institute of Applied Manpower Research in collaboration with industry and the State Governments.

13.14. In addition to this, it is necessary that the speciality-wise assessment of technician demand including the analysis of occupations should become a continuous activity so that technician education may at all times be geared to meet the changing technician manpower needs and the changing requirements of technician jobs. The Committee has therefore recommended the setting up of special units in the Directorates or Departments in charge of technical education in the States. At the Centre, this should be one of the responsibilities of a separate unit in the technical division of the Ministry of Education in its function as the Secretariat of the proposed Committee on Technician Education and Training.

13.15. In this context, the Committee reiterates a suggestion made by the Education Commission that investigations should be carried out in cooperation with industry, aimed at job analysis and specifications in terms of levels and clusters of skills and responsibilities for technicians. It is learnt that the All India Manufacturers' Organization is sponsoring a comprehensive survey in this regard to be undertaken jointly by the National Institute for Training in Industrial Engineering and the Institute of Applied Manpower Research. The Committee welcomes this survey and recommends that it should become a regular feature.

13.2. Reorganisation of Existing Polytechnics

13.21. The main emphasis of this report is upon the need to coordinate the educational programmes in polytechnics with such training in industry as would help to turn out technicians who will meet the actual manpower needs of industry. For this purpose, a number of recommendations have ben made for (a) modernisation of the curricula for conventional courses; (b) reorientation of courses in relation to newer fields of activity in rural areas, non-industrial urban areas and industrial areas, depending upon the location of polytechnics; (c) introduction of courses related to technician level occupations in commerce, business and other fields; (d) introduction of special courses in Women's polytechnics; (e) introduction of diversified courses wherever possible; (f) organisation of sandwich courses in cooperation with industry; and (g) provision of suitable programmes for skilled craftsmen and technicians working in industry to equip them better for their present as well as future work. Recommendations have also been made for changes in the structure of staffing the departments the addition of training and placement, and guidance and counselling, services in the polytechnics and improvement in the existing methods of learning and teaching processes including better campus and library facilities. It is suggested that these recommendations be studied by all the individual polytechnics and adapted into an integrated plan of development of the concerned polytechnic. This would require an acceptance, by all concerned of the need for planning at the institutional level and for strengthening the institutions to undertake this function efficiently and with competence.

13.22. It is not the idea of the Committee that this effort on the part of the individual institutions will substitute the need for action at the State and the National levels. On the other hand the strengthening of development planning at the level of an institution, which is strongly recommended, will supplement the data-base for policy formulation by the appropriate agencies in the State and Central Governments.

13.23. In formulating development plans, the polytechnics should be "outward-looking" to take note of the actual needs of the community they serve; in that process, they would also be "forward-looking" in as much as their plans would be related not only to the current situations but also to future trends. The proposals in this regard by Principals and senior faculty members, polytechnics should receive careful consideration and support from the Government and the industry.

13.3. Autonomous Institutions

13.31. The Committee has also given sufficient thought to the question as to how the necessary momentum can be generated with the technician education system, in order to make it dynamic and alive to the changing requirements of industry and the changing methods and concepts of education. In our country of vast dimensions, with varying levels of economic and industrial development and diverse sociocultural patterns, it is neither possible nor necessary to aim at total uniformity in our approach to the development of technician education. Furthermore, the Committee is of the view that innovations and experimentation should be sponsored, promoted and encouraged keeping in view the limited financial resources likely to be available for the purpose. This should initially be done in selected polytechnics which, in due course, would set the pace and direction for all the other institutions. Such institutions should be accorded sufficient flexibility and freedom without being hampered by routine regulations aiming at uniformity at the 'average' level.

13.32. It has accordingly been recommended that about 25 polytechnics (comprising at least one and not more than two polytechnics in each State or Union Territory) should immediately be selected and developed into autonomous institutions with sufficient administrative authority, academic freedom and flexibility and financial resources so that they may initiate worthwhile experimental projects in the field of technician education. These projects should include the identification of technician areas, design of new courses of study and training, organisation of suitable types of programmes in association with industry, formulation of rational curricula and teaching methods and aids, and development of better systems of assessment and evaluation.

13.33. These institutions should be selected from those which maintain high academic standards and competence and are located conveniently close to industries and establishments which are most forward-thinking in technical development and professional training.

13.34. Each selected polytechnic should prepare a detailed plan of its development projects and evaluate the progress periodically in consultation with the State Government concerned, professional bodies, industry and the Regional Committees of the All India Council for Technical Education.

13.35. It is recommended that the State Governments should endeavour to develop all the existing polytechnics into autonomous institutions during the next 10 years.

13.4. State Council of Technical Awards (SCTA)

13.41. In order to facilitate the rapid and effective reorganisation of educational programmes through the flexibility and freedom of polytechnics to experiment with new courses, patterns, new methods of course organisation, evaluation and assessment and at the same time to set and maintain high standards in accordance with national requirements. it has been recommended that an autonomous and independent body to be called the State Council of Technical Awards should be set up in each State. The State Governments may determine the manner and method of setting up the State Council of Technical Awards and specify its relationship to the State Board of Technical Education.

13.42. The SCTA should be assigned the responsibility to look after all academic aspects of technician education in polytechnics in the State. Besides guiding the autonomous polytechnics and evaluating their progress the Council would assist all the other polytechnics in the State to frame new courses and provide guidance in respect of the maintenance of standards of instruction and the reform of examinations. The Council would advise the Government on the selection of polytechnics for autonomy, and also on measures to develop all polytechnics towards the attainment of high standards of facilities, faculty and performance.

13.43. The Committee has recommended that selected polytechnics should in due course be authorized to conduct part-time degree courses for technicians. Such a measure would contribute to enhance the status of polytechnics, their teachers and the technicians. The SCTA could play a valuable role in fostering the development of polytechnics along these lines, by becoming, in due course, important organisations for the award of degrees and diplomas for students of post-matric education, higher education and polytechnics.

13.5. Committee on Technician Education and Training

13.51. If the proposals of reorganisation of polytechnic education are to be implemented speedily and effectively. the administrative and advisory machinery at the Centre and in the State need to be geared up. The Committee has therefore recommended that a Committee on Technician Education and Training should be constituted under the auspices of the All India Council for Technical Educacation to advise the Council on all matters relating to the coordination and development of technician education in the polytechnics.

The functions of the Committee would be:

(i) to plan and keep under review the development of a unified national pattern of education for technicians in industry, commerce and other services, and

(ii) to advise the All India Council for Technical Education on the establishment and development of suitable courses and the assessment of standards of performance of various institutions.

13.52. The proposed Committee may be constituted with about 15 to 20 persons drawn from those interested in technician education, experts from industry and commerce and representatives of professional bodies. In order to give efficient secretariat help to the Committee, a separate unit may be created in the Ministry of Education.

13.6. A Crash Programme of Teacher Training

13.61. The Committee is convinced that the success of implementation of its recommendations regarding qualitative improvement of polytechnic education depends to a large extent upon the responsiveness of the faculty to such programmes. In particular, it refers to the need to bring about a practical orientation of polytechnic teaching to adopt modern methods of instruction based on live problems of the industry, and to develop in the faculty appropriate skills of communication and teaching.

13.62. In order to start the process of improvement of the quality of polytechnic education in a comprehensive manner, it is recommended that a crash programme be formulated by the State Govt., preferably in consultation with the State Council of Technical Awards, to cover at least 25 per cent of the teaching staff during the next three years. This should aim specifically at (a) training teachers on such aspects of polytechnic education as evaluation and assessment, curriculum development, industrial orientation to teaching and reorganisation of laboratory programmes, (b) providing them with training in industry for a period of about 3 months so as to help link class-room instruction with the practical needs of industry with particular reference to problems of design, process and production control, selection and use of machine tools and manufacturing processes; (c) improving the art of teaching for effective transfer of knowledge and skills and (d) training workshop instructors in the technique of imparting manipulative skills.

13.63. Such a crash programme is required not only for the selected autonomous polytechnics but also for all other polytechnics. The programme should be implemented in close cooperation and industry, Technical Teacher Training Institutes and other training and educational agencies under the universities and the Directorate General of Employment and Training.

13.64. The State Governments should prepare, in consultation with the SCTA, a perspective plan of faculty development by assessing (a) the number of teachers to be selected annually for training in industry, for updating of subject-knowledge and for education in teaching principles and techniques; (b) the levels and categories of such teachers; (c) the types and places of such training; (d) the provision for a training reserve in the staff structure; and (e) the financial implications of such a programme. During the next ten-year period all the faculty members in polytechnics should have completed a programme of professional training, based upon the type of technician courses offered and the presonal needs of the teacher concerned.

13.65. Closely related to the above suggestion for faculty development is the preparation of laboratory projects, manuals, casebooks of problems, teaching aids etc. for polytechnics. The Committee has expressed its view elsewhere that the present practice of equipping laboratories according to a standard list should be discontinued. In its place there should be carefully prepared lists of equipment which would take into account the types of technician courses, the pattern of their organisation viz. sandwich, part-time or full-time and the nature and kind of educational situations to be provided in the different laboratories. The autonomous polytechnics, which have been recommended, should take up this work on a high priority basis with such guidance and help as will be available from the State Council for Technical Awards, industry, professional bodies like the Indian Society for Technical Education and the Institution of Engineers (India) and the Technical Teacher Trainning Institutes.

13.7. Teachnical Teacher Training Institutes

13.71. It is noted that these Institutes are presently in a process of establishment and that it would take some more years before they are in a position to provide their servicing facilities to all polytechnics in the concerned regions. In devising their programme of work for the immediate future, these Institutes should attempt to coordinate their work to supplement the proposed activities of the autonomous polytechnics so that the thrust for modernising polytechnic education is generated a wider front.

13.72. One way of ensuring this would be for these Institutes to associate in their academic bodies the principals and senior members of the faculty of selected polytechnics. It is desirable that the principals of the Central Craft Teachers Training Institutes (CCTTI) should also be associated. The Technical Teacher Training Institutes should establish a continuous and intimate dialogue with the polytechnics with regard to their programmes. It is understood that one Institute has already initiated an extension service to all the polytechnics located in its region. This programme should be commended to all the Institutes. The Committee also hopes that the polytechnics will use the facilities in these Institutes for a variety of educational purposes and not merely to depute their faculty for conventional training courses.

13.73. A suggestion has been made to the Committee that admission to polytechnics should be based on aptitude tests. The Committee was also told that efforts are being made by the Directorate General of Employment and Training and the National Council of Educational Research and Training to evolve and validate tests which would be "culture-free" and suitable for students irrespective of their rural/urban background or socio-economic status. The Committee recommends that the Technical Teacher Training Institutes should take up this work in collaboration with other concerned agencies and develop batteries of tests suited to the specific requirements of technician education and training.

13.8. Training in Industry

13.81. The proposals for inititting action for training in industry of faculty and of students have been made earlier. In order to facilitate quick progress in this direction, it is suggested that each establishment in industry, commerce and public utilities should immediately set up a separate unit for developing liaison with polytechnics and help them formulate, implement, supervise and evaluate specific training in industry. Their training officer will also associate himself with the design of the institutional part of technician education.

13.82. Some of the other proposals of the Committee in connection with augmenting training facilities for students are:

(i) Setting up of Production-cum-Training centres at places where two or more polytechnics are situated in order to provide practical training to the students of other polytechnics in rural and non-industrial areas.

(ii) Establishing closer links between polytechnics and Industrial Training Institutes.

(iii) Setting up Industrial Training Institutes in the proximity of polytechnics in non-industrial urban and rural areas.

(iv) Setting up of Training and Placement departments in all polytechnics.

13.9. Library Services and Textbooks

13.91. In the reorganised set up of polytechnic education, the aim is to modernise the educational process through, among others, an increasing emphasis on developing attitudes and motivations to learning. Consequently, the Committee attaches considerable importance to the provision of better library facilities and to an extensive system of self-study and home assignments. In order to implement this recommendation, it is necessary to view the role of library as an effective medium of education and to ensure sufficient support to the development of well-stocked, well staffed and attractive libraries in all polytechnics.

13.92. An equally significant recommendation the Committee makes is about textbooks and course materials for technician education. It draws pointed attention to the present deficiencies in this regard, *e.g.* the non availability of suitable textbooks which are intelligible to the average students with the current socio-cultural background, adapted to local technology and engineering practices and sold at a price the students can afford. It is also the Committee's view that more and more textbooks should be written by the teachers in the polytechnics themselves, using case materials and examples from the Indian situations. With the training of teachers in industry, which is recommended as a pre requisite for ploytechnic faculty, the teachers would be in a better position to prepare text-books suited to our polytechnic students. In this connection, the Committee strongly recommends that the Central Government should immediately formulate a scheme to give encouragement and incentives to practising teachers and professionals to write standard textbooks for technician courses and to print and publish them at reasonably low prices.

13.93. The Committee hopes that the services of the Indian Society for Technical Education, the proposed State Council of Technical Awards and the Technical Teacher Training Institutes will also be available for the programme of book production.

13.10. A Blue-print of Action

13.10.1. The report covers a wide range of subjects relating to ploytechnic education and training in which industry, polytechnics and government are partners. The success and effectiveness of its implementation therefore depends on the simultaneity, timeliness and speed with which each of these agencies initiates action.

13.10.2. What the Committee hopes for its quick action at the national level through the All India Council for Technical Education, in which all these agencies are represented. A blue print should be prepared early enough to facilitate careful consideration of the reforms proposed and to give concrete shape to them. Such a blue-print should spell out, among other things a time-schedule for implementation of the specific recommendations, the financial costs involved, including a pattern of sharing such costs, organisational needs and a definition of authority and responsibility among the concerned agencies.

13.10.3. The Committee recommends that the Technical Division of the Ministry of Education and Youth Services should be assigned this task and a separate unit established to process the several reforms proposed in this report. That unit should also serve as the secretariat to the Committee on Technician Education and Training which is recommended to be set up as a Committee of the All India Council for Technical Education.

CHAPTER XIV

SUMMARY OF RECOMMENDATIONS

Chapter II: A Review of the Development of Polytechnic Education

1. Polytechnic education should be coordinated with the state of industrial and commercial development and the economic resources of the country as a whole.

2. Over the next 10 years, higher priority in technician education development should be accorded to the qualitative improvement of courses and consolidation of existing institutions rather than to quantitative expansion.

3. At least for the next five years, there would be no need to consider the establishment of new polytechnics. As for the intake capacity of existing ploytechnics, the position may be reviewed after three years and any changes necessary be made so as to meet the actual needs.

4. Efforts should be made to prepare realistic estimates of the demand for technicians for the fifth and subsequent plans, region-wise and by specialities and types of technician functions in industry, commerce, services and public utilities, so that appropriate programmes of educational development could be formulated and included in the Fifth Five Year Plan.

Chapter III: Concept of Technician and His Education

5. In Industrial organisations there is a broad spectrum of occupations lying between the craftsmen at the one end and the professional engineer at the other. Within this spectrum there are wide differences, both in specialities and degrees of expertise, which must be taken into account when planning educational and training programmes, but the whole band represents a separate and distinct group of people, who can be classified as technicians whatever their specific functions may be. Polytechnics, in association with industry and business, should have the responsibility of educating and training persons for technician functions.

6. The purpose of polytechnic edcucation is to lay the foundation for the future technicians and for the persons who play a comparable role in business and commercial activities by way of a sond, broad-based theoretical knowledge of the chosen field that helps them to understand the basic principles underlying their activities together with training in the actual practice thereof.

7. Technician education should not lose sight of the human and social aspects of the work and life of technicians. The confidence and competence needed for self-employment should also be developed.

8. Programmes of technician education and training should be properly drawn up in an integrated manner with the cooperation of industry.

Chapter V: Reorganisation of Polytechnic Education

9. The major concern of polytechnics should be to run regular diploma courses designed to meet the educational requirements of the technician positions near the professional level. At the same time, it should be the endeavour of polytechnics to extend their institutional facilities to cater to the needs of the other category of technician positions by organising a variety of short-term and/or part-time courses for technicians and craftsmen in service.

10. Apart from these courses, polytechnics should organise special refresher and training courses as well as advanced diploma courses for technicians already employed.

11. Certain selected polytechnicians should be authorised to offer part-time degree courses.

12. Part-time diploma courses should be started at the initiative and with the cooperation of industry in selected subject fields so as to benefit a large number of skilled persons working in the local industrial and business firms.

13. Within the board framework of certain general guidelines as regards the standards, objectives and scope of technician courses, there should be a great deal of flexibilty in course plannning to permit local variations in their structure, contents and organisation.

14. Where two or more polytechnics are situated in a centre, coordination should be brought about in order that they may avoid duplicating their efforts in the kinds of courses they offer.

15. Technician courses should aim to prepare the student for entrance into a technician function and at the same time facilitate mobility and future occupational advancement.

16. At present, narrow specialization should not be the aim of technician courses at the first diploma level. The courses should be designed to be broad-based with provision for diversification.

17. Diversified courses should be started in those institutions where the need for such course is fully established and may be introduced, in the initial stages, by means of elective subjects within the broad-based diploma courses.

18. In order to correlate the polytechnic educational programmes with the diverse needs of technicians from time to time, well-organised units should be set up in the departments in charge of technical education at the Centre and in the States for the estimation of future technician needs, speciality-wise on the basis of analysis of occupations.

19. A technician who emerges from a diploma course should be in a position to tackle most jobs that he may be confronted with. Hence there is need for planning education and training programmes on the basis, of analysis of occupations by functions. However, the education should look beyond the boundaries of such occupation-analysis because,

in developing countries like India, the technician may have to deal with activities related to, but not necessarily part of his basic functions.

20. Sandwich courses should be started only after specific study in depth about the adequacy of the industrial cooperation available at any proposed location. They should be so organised that the industrial training is effectively supervised, coordinated and evaluated by the polytechnics and the industry.

21. Educational programmes in engineering fields should be given a design and production orientation appropriate to the level of technician functions.

22. Polytechnics should also offer courses in fields such as commerce business administration etc. which are closely related to industrial activities.

23. A variety of courses suitable to the temperament and special aptitudes of girls should be organised in Girls Polytechnics. In particular, diploma courses in Home Science and Home Economics options should be introduced in all Girls' Polytechnics.

24. In respect of polytechnics situated in non-industrial areas, a careful study may be made of the types of courses required for those regions and in the light of such study suitable courses may be organised. However these institutions may concentrate on offering generalisd courses. Efforts should be made to set up Industrial Training Institutes in their vicinity to stimulate their growth.

25. Polytechnics in rural areas may offer courses in agricultural engineering and courses applicable to agro-industries. In such areas, the possiblility of setting up Industrial Training Institutes in the proximity of the polytechnics may be considered with a view to augmenting the training facilities for students.

26. The duration of polytechnic courses should be determined with reference to the nature and requirements of each course. The following normal durations are recommended:

i. Full-time institutiontl courses at first diploma level: 3 years.

ii. Full-time Sandwich courses at first diploma level: 3 1/2 years.

iii. Part-time evening courses at first diploma level: not exceeding 4 years (Actual duration should be governed by the subject unit requirements)

iv. Advanced diploma courses: one year.

v. Short term and special courses: Duration should depend on the subject matter requirements of the course.

27. The minimum academic qualification for admission to a course at the first diploma level should be a pass in the Pre-University course or Higher Secondary course or its equivalent. Students who have passed only the SSLC or matriculation should undergo successfully a preparatory technical course of one year in the polytechnics.

28. The curriculum of technician courses should be based on a clear definition of the objectives of each course—both the specific objectives of technician specialities and the general objectives of technician education.

29. The curriculum should be flexible enough to permit addition or deletion of subjects and alteration in their levels depending upon the pre-entry preparation, the varying needs of industry and the direction of technological changes.

30. The syllabi of polytechnic courses should be regularly reviewed and revised to meet the changing requirements.

31. Syllabi should not merely specify the topics but should indicate the depth of their treatment.

32. Whenever changes are to be effected in the curriculum it is desirable to take into account the views and suggestions of students.

33. Curricula should be designed to enable a study in depth of the subjects of specialisation and a broad coverage of other related subjects.

34. The study of basic sciences should be properly oriented to suit the needs of each course and should not only enable the student to understand and learn the technical subjects that follow but also lay the foundation for future adaptability and further studies. They should be taught as subjects interwoven into the other subjects.

35. The study of English language should be emphasized and developed as a tool of effective communication for technical purposes.

36. As and where relevant to the needs of technician courses, study, in appropriate depth, of topics from industrial Organisation, Human Relations, Factory laws and Labour Laws, Materials Management, Industrial Hygiene, Industrial Safety and Concepts of Systems Engineering should be included.

37. Polytechnic education should develop in the students practical skills and the attitude to understand appreciate and apply concepts to practical situations through carefully planned laboratory work, workshop practice and project work.

38. Practical work must form a substantial part of technician courses, particularly of the full-time regular courses. It should reflect similar work in industry, commerce or other field as closely as possible, within the limitations of institutional facilities.

39. Project work requiring design and/or fabrication should find an important place in the final year of the diploma programmes and in the advanced diploma courses. Project work must be based on real problems involving industrial/commercial practice and procedures.

40. Through co-curricular and extra curricular activities and seminars and project work, polytechnics should endeavour to develop in their students the confidence and competence needed for self-employment.

41. The main criteria in planning laboratory work and practical/field work should be (i) to further a clear understanding of the scientific principles taught, (2) to foster innovation and original thinking, (3) to help develop the ability in the crtative use of knowledge and critical appraisal of test results, (4) to develop an appreciation of, and a facility in, the use of the experimental and approach to problem solving and (5) to encourage the fabrication and assembly of simple types of instruments and scientific apparatus and set-ups.

42. The main objective of workshop practice should be to give the basic training so as to lay the foundation, for later shopfloor experience. Workshop practice should aim at helping students to understand, apply and use the basic principles, skills, tools and processes.

43. The equipping of laboratories and workshops should be governed by a careful consideration of the needs of the courses, the teaching approach of the polytechnics and the availability of equipments in collaborating industry and the Industrial Training Institutes situated in the neighbourhood.

44. The present practice of rigidly following "Standard" lists of equipment should be discontinued although they could serve as guides of minimum requirements. Each polytechnic should determine the requirements of laboratory and workshop equipment. having regard to the nature of the courses offered from time to time.

45. Provision should be made for appointing competent laboratory technicians in each laboratory for the proper maintenance and upkeep of laboratories and equipment.

46. The faculty of polytechnics should be encouraged to develop and fabricate items of laboratory equipment needed for the courses. Deserving proposals in this regard should receive financial support.

47. Technical Teacher Training Institutes should collect details of equipment devised and fabricated by polytechnics and circulate the details to all polytechnics in the country.

48. In addition to the regular teaching methods. the more modern and effective methods including the tutorial method, the problem-solving method, the project-method and seminar method should be used in polytechnics.

49. Wherever possible. lectures should be supplemented by audio-visual aids such as slides, film-strips, blow-ups, charts, films, class room demonstration models and instruction sheets.

50. A concentrated effort is required to develop teaching aids. Polytechnics should be provided with audio-visual equipment such as over-head projectors, film and slide projectors, epidioscopes etc.

51. Technical Teacher Training Institutes should develop and produce proto-types of all kinds of teaching aids. They should also keep in touch with polytechnics, other institutions and firms engaged in the development and production of teaching aids and disseminate information about them to all polytechnics in the country.

52. Case-studies of actual industrial and field problems should be collected by teachets for use in the class-room. The Technical Teacher Training institute sshould compile these problems and bring out case-books and catalogues of case-studies. These should be made available to all polytechnics.

53. Incentives should be provided to teachers and experienced persons in industry to write textbooks and other supplementary course materials suitable for the different courses and publish them at reasonably low prices.

54. Textbooks in use should be scrutinised from time to time and brought uptodate.

55. The use of the library by teachers and students for reference, information and self-development must be encouraged and fostered. The teaching should be so organised as to require and encourage a great deal of self-study and use of library facilities by the students.

56. All polytechnics should have well-stockd, well-staffed and attractive libraries, with reading room facilities for at least 10 per cent of the student body. Necessary provision should be made for creating and maintaining adequate library facilities and services and for the periodic addition of books and journals.

57. The library should be in the charge of a well-qualified, competent and well-paid librarian with adequate staff to assist him. The librarian should be given a grade at least equal to that of a lecturer and granted the status of the Head of Department.

58. Separate text-book libraries should be set up in the polytechnics and, if possible, in the Halls of Residence, for the benefit of students.

59. For the proper development and growth of technician education and its improvement in quality, autonomy for polytechnics is essential, polytechnics should have complete freedom to experiment with much-needed reforms, restructure their courses establish co-operative relationships with industry in their region in training and employing technicians, develop the new curricula suited for such courses. evolve their own methodology for education and training and assess and evaluate their students.

60. A beginning must be made by selecting at least one, but not more than two, polytechnics in each State and Union Territory for the immediate grant of autonomy. These polytechnics must be selected on the basis of the sustained excellence of their standards, facilities, faculty and performance. Based on the expeirence gained with the working of the autonomous polytechnics initially selected, other polytechnics must be given such freedom as and when they are ripe enough to take up such responsibilities. For this purpose the polytechnics must be assisted to attain the required standards and levels, through a phased programme of development over the next 10 years.

61. In addition to academic freedom, the autonomous polytechnics must be provided with necessary administrative authority and financial resources.

62. To plan and implemnt the development programmes on the right lines, each autonomous polytechnic should have a Governing Council and an Academic Board.

63. The Governing Council of an autonomous polytechnic will be responsible to guide and control the planning, development and administration of the polytechnic and should consist of teachers' representatives of the State Council of Technical Awards (recommended later) the State Board of Technical Education, the All India Council for Technical Education and the State and Central Governments. The principal of the polytechnic should be the member-secretary of the Council.

64. The Academic Board of an autonomous polytechnic will deal with such matters as assessment and evaluation course development, relations with industry, research, and other academic matters. The proposals of the Academic Board should be placed before the Governing Council for ratification. The Academic Board should consist of representatives of the faculty, experts from industry and eminent educationists in the fields of technical and secondary education. The principal of the polytechnic should be the chairman of the Board.

65. A State Council of Technical Awards (SCTA) should be set up in each State as an independent and autonomous organisation to coordinate and safeguard the necessary standards with respect to technician education and to award diplomas.

66. In respect of the autonomous polytechnics, the SCTA should set and assess standards not by framing and imposing courses and curricula and conducting examinations but inspecting and approving the institutions, scrutinizing and approving new courses and curricula, and schemes of assessment and evaluation, framed by the polytechnics themselves.

67. The SCTA will lay down the standards by way of facilities and faculty and the general guidelines and requirements for courses.

68. In respect of the non-autonomous polytechnics, the SCTA should help them to frame and improve their courses and curricula conduct the external examinations and suggest the methods of internal assessment.

69. The SCTA should assist the non-autonomous polytechnics to devlop the standards of facilities, performance and expertise needed to gain autonomy.

70. The State Government should determine the manner and method of setting up the SCTA and specify its relationship to the State Board of Technical Education. The SCTA should consist of representatives of industry, trade and commerce, technical experts from government departments, representatives of the professional bodies, progressive educationists, polytechnic and college teachers and princpals etc.

Chapter VI: Faculty

71. The normal pattern of teaching staff categories in a polytechnic should be as follows:

Professor of Head of the Department;

Assistant Professor: and

Lecturer/Associate Lecturer.

The ratio between senior position and junior positions i.e. Professors/Assistant Professors and Lecturers/Associate Lecturers should be of the order of 1:2.

72. The teacher-students ratio should be not less than 1 : 10. In counting this ratio only teaching posts of Associate Lecturers and above should be taken into account.

73. For every diversified course in an institution, at least one professor assisted by an assistant professor or lecturer should be provided, supplemented by part-time lecturers from industry.

74. Principals and Heads of Departments of polytechnics should be provided with suitable administrative staff. Provision should be made for clerical and laboratory assistance to teachers.

75. The designations and scales of pay of teaching posts in polytechnics should be the same as in engineering colleges.

76. The minimum qualification for the post of Associate Lecturer should be a degree in engineering or technology with at least two years of industrial experience. However, a diploma holder with not less than 5 years of industrial experince may be considered subject to his suitability to teaching and improvement of his academic background.

77. The minimum qualification for posts of lecturers and above should be a degree in engineering or technology, or AMIE with at least 3 years of industrial experience or a TTTI diploma with five years of industrial exeperience.

78. For teachers of other professional courses like commerce and business, the minimum qualification should be a degree in the appropriate field with 2 years of professional experience in the relevant field.

79. For teachers in science, humanities and arts, a post-graduate degree is essential, preference being given to persons with industrial exeprience.

80. Training of at least one year in the art and techniques of teaching is desirable for all polytechnic teachers.

81. All teachers of similar categories whether in engineering, business and commerce, or humanities, arts and science should be allowed the same scales of pay and benefits.

82. For all teachers from the Associate Lecturer to the Assistant Professor, there should be a composite scale of pay with suitable starting stage for each category.

83. In view of the industry/application orientation of teaching in polytechnics the practice of transferring teachers between polytechnics and arts and science colleges, wherever it exists, should be discontinued.

84. Suitable incentives should be provided for teachers to improve their academic qualifications and gain experience.

85. Teachers deputed for training etc. should be paid their full salary in addition to travelling and other allowances and stipends.

86. Subject to certain conditions, polytechnic teachers should be given the freedom to take up consultancy work.

87. Polytechnic teachers may be allowed to take sabbatical leave to pursue research or undertake writing of books or to work in other institutions or industry.

88. Industry must be willing to accept, encourage and assist the transfer of experienced staff to part-time and full-time teaching work. There must be a much greater interchange of staff between industry and polytechnics.

89. Opportunities should be made available to teachers for acquiring the needed industrial experience, training in the art and techniques of technical teaching and higher academic qualifications through seminars, short term courses of various kinds, summer institutes, in-service training programmes, deputation to Teachers Training Institutes during vacation or during the academic year and secondment to industries. Teachers must be required to attend such courses and acquire such training several times during their career to facilitate continuous development and to remain uptodate in their field of knowledge.

90. Specially designed short-term courses should be organised for providing industrial training to workshop instructions. The cooperation of the Central Training Institutes should be secured for providing training to workshop instructions of polytechnics in respect of skill appreciation.

91. A crash programme should be implemented for retraining at least 25 percent of the existing polytechnic teachers within a priod of two years. The programme should consist of several courses of short duration on such subjects as assessment and evaluation technique, curriculum development, laboratory work and industrial orientation in teaching.

92. This crash programme should be followed by a second stage of comprehensive industrial training especially for teachers in certain subjects which are highly practice-oriented or industry-oriented.

93. A third stage of training of longer duration should cover training in communication skills.

94. A crash programme should be organised at selected centres in India for Principals of polytechnics to familiarize them with the different aspects of polytechnic education and management and its reorganisation as recommended in this Report.

95. Teachers of languages, mathematics and the physical sciences should be given special maintation courses in the application-based teaching of these subjects.

96. Each State should (a) assess the total number of teachers to be trained annually in the first ten years, (b) indicate the type of training programme relevant to Instructors, Associate Lecturers, Lecturers and Heads of Departments to be planned for, (c) work out financial estimates and (d) implement phased programmes of training.

97. The main functions of the Tchnical Teacher Training Institutes should be:

(a) Organising courses on the art and techniques of teaching and special subject-teaching courses.

(b) Research and training on the methods of assessment, evaluation and grading.

(c) Research and training in teaching methods and development and production of teaching aids, charts and publications.

(d) Collecting and diseeminating to all polytechnics in the country, information on curricula, examination systems, equipments, teaching aids, technical literature, teaching methods etc.

98. Close liasion should be established and maintained between the Technical Teacher Training Institutes on the one hand and the principals and senior faculty members of polytechnics on the other.

99. In order that the Technical Teacher Training Institutes could be successul and effective in their function of training polytechnic teachers, the TTTI's should maintain close relations with industry. The faculty of TTTI's should be encouraged to return periodically to polytechnic teaching and industry.

100. TTTI's should organise short-term courses for lecturers and instructors on the fabrication and use of teaching aids.

101. The Technical Teacher Training Institutes should concentrate their energy on the several aspects of teacher training rather than on organising postgraduate courses in subject specialisations.

Chapter VII: Students

102. Information about technician courses and careers should be collected by the Directorates or Departments in charge of Technical Education and transmitted to the educational authorities concerned with institutions conducting pre-university or Higher Secondary courses for due circulation and publicity.

103. While the performance in an aptitude test should be one of the criteria for admission to polytechnics, its wholesale adoption at the present stage is not favoured. However, a beginning should be made to develop some standard aptitude tests for admission to polytechnics.

104. Admission should be made by polytechnics on the basis of merit. Some weightage may be given for participation in extra-curricular activities.

105. Guidance and Counselling Services are essential in Polytechnics to give direction and purpose to the aspirations and activities of students and to assist them to make decisions and adjustments from time to time in respect of their academic, family, social and vocational-educational problems. To begin with, Guidance and Counselling Centres should be set up on an experimental basis, in the autonomous polytechnics. Depending on the experience, the scheme should be extended to cover all the other polytechnics in the course of the next 10 years.

106. Each Guidance and Counselling Centre should have a Guidance and Counselling officer of the rank of a professor, assisted by suitable staff. The officer should be professionally qualified with adequate training in educational psychology and vocational guidance. The Centre will need to have library facilities and testing laboratory for assessment and diagnosis of students' abilities and disabilities.

107. Arrangements should be made in all polytechnics to provide hostel facilities for at least 50 per cent of the students.

108. Polytechnics should take interest not only in the time students spend in the campus but also in the time they spend outside the campus. Interest to do indpendent work and study, and in hobbies outside formal study hours, should be cultivated in the students. The rquired facilities for extra curricular activities such as sports, music, arts, histrionics etc. should be provided to develop and foster healthy community life. Student organisations and activities should be encouraged to enrich campus life.

Chapter VIII: Assessment and Evaluation (Examinations)

109. The assessment of a student should be continuous and should ultimately be the responsibility of the teachers themselves.

110. The overall internal assessment of a student's performance and progress should take into account his achievements in assignments, periodical tests etc.

111. An immediate and complete changeover to purely internal assessment, even though desirable, may not be feasible in all polytechnics in our present set up. Therefore, to begin with, in respect of the non-autonomous polytechnics, continuous internal assessment should be given equal weightage with the final external examination. Complete switchover to continuous internal assessment should be effcted within a period of 10 years.

112. The State Council of Technical Awards should continuously review the method of assessment and evaluation in each polytechnic and suggest necessary improvements.

113. Training courses in the methods of assessment, evaluation and grading should be arranged for teachers in the form of short training programmes, summer courses etc.

Chapter IX: Training and Employment

114. Basic training covering the basic skills should normally be provided by the polytechnics themselves. For this purpose, the workshop facilities in polytechnics should be strengthened. Wherever possible, closer links should be established between polytechnics and Industrial Training Institutes.

115. Secondary training should be organised as practical training in industry and should have as its objective a broadening of technical knowledge and gaining of insight into some of the workings and problems of industry in general. In its later stages, the training should be more specifically related to the actual work on which the technician student will be engaged when he has completed his training.

116. The training programme should introduce the potential technician to a variety of operational problems obtaining in the practice of his occupation, whether these relate to the selection of operational procedures, manufacturing processes, machines, materials and methods, or to the ensuring of control of production sequences, quality and cost. It should also expose him to conditions of work involving, among other things, organisational procedure, group activities human relations and production economics.

117. The programme of practical training should be carefully drawn up by individual polytechnics in cooperation with the collaborating industrial units to suit the needs of each course and should be properly and jointly supervised by the institution and industry.

118. Training must be properly assessed and evaluated. It should preferably have adequate weightage in the total evaluation. There is a need to devise adequate scientific methods to assess the results of training and evaluate the degree to which the objectives of training have been realized.

119. It should be the endeavour of all concerned to make arrangements to provide well-organised and supervised practical training in industry for all students of diploma courses during vacations and/or after the completion of the courses.

120. Production-cum-training centres may be set up at places wherever two or more polytechnics are situated. The facilities available at these centres should also be used for providing training during vacations or after the diploma courses. The centres could also provide practical training to students of polytechnics in rural areas where industries do not exist.

121. Since several government departments, such as industries labour technical education, are administering several kinds of training programmes, an effective coordination of their efforts should be brought about.

122. A separate training and placement department should be set up in each polytechnic manned by an experienced training and placement officer of the rank of a professor with suitable assistance.

123. Training departments must be set up in all organisations offering training facilities manned by capable executives who could work in close collaboration with the principals/heads of departments and training officers of the polytechnics.

Chapter X: Partnership with Industry and Commerce

124. Industries should be fully involved in the planning and development of polytechnic education and in the training of diploma students at every stage.

125. At the national, regional and State levels, partnership must be strengthened. Industry must be adequately represented in the policy-making and coordinating bodies at these levels and must be closely associated with the proposed State Councils of Technical Awards and the autonomous polytechnics. At the unit level, conditions must be created which favour the close collaboration of industry in the implementation of the programmes of education and training.

126. Industries should be requested to extend their fullest cooperation in providing the much-needed industrial experience to polytechnic teachers either by short-term or long-term training or through other arrangements.

127. Industries in the neighbourhood of polytechnics must be encouraged to refer their search, development and production problems to the polytechnics. Industries may also support other research or development projects undertaken by polytechnics.

128. Experts from industry should be invited to discuss some typical problems of the shop-floor and explain through special lectures and seminars how they are solved. They may also provide the polytechnics with technical information and details of their design, development and production activities.

Chapter XI: Status and Professional Development of Technicians

129. There should be a rationalization of the manpower structure and a clear identification of technician functions in industry and commerce. Technicians must be accorded a recognisable career structure adequately reflecting the importance of their position. Formal technician qualifications should be insisted upon for recruitment.

130. Polytechnics should organise a variety of updating, refresher and extension courses including short-term and advanced-diploma courses and part-time degree courses for technicians in service. Through these courses, technicians should be enabled to qualify for higher positions and promotions.

131. The image of polytechnics as centres of career education should be developed. For this purpose, polytechnics should have the flexibility and freedom to develop in new directions and explore new horizons.

132. Technicians should have an organised forum for discussing common problems and articulating their needs and aspirations.

133. The Government should take the initiative in persuading the professional bodies and other organisations and associations concerned with technical education, training, industrial and commercial interests etc. to set up technician sections/technician education and training sub-committees etc. The teachers of polytechnics should also be involved in these sections and sub-committees.

Chapter XII: Administration, Finance, Control and Inspection

134. While a strong national policy on technician education and training is necessary, such a policy should be flexible enough to permit modification according to the peculiar regional or local needs with reference to the type and level of technicians.

135. The responsibility for the administration and control of technician education should be shared appropriately by bodies at the Central, Regional, State and Unit levels. The responsibilities at each administrative level should be properly defined.

136. A separate Committee on Technician Education and Training should be constituted under the auspicious of the All India Council for Technical Education to deal with all aspects of technician education and training at the national level.

137. In order to give efficient secretariat help to the proposed Committee on Technician Education and Training, a separate unit may be created in the Ministry of Education.

138. The regional committees of the AICTE and the regional organisations of the Central Government may have to be reorganised.

139. Detailed studies of manpower demands in the State, training in industry, programmes of development, teacher development and administration of polytechnics with respect to financial control and coordination at State level, should be the direct responsibility of the State Government so that programmes and schemes may be effectively implemented.

140. A State Council of Technical Awards (SCTA) should be set up in each State.

141. There should be adequate delegation of administrative authority and financial power to the Heads of Polytechnics to function efficiently.

142. As regards the financing of polytechnic education, the Government has to take the major responsibility both at the Central and State levels but industry should also be a party to the financing as it directly benefits from it.

143. So far as new experiments and innovations in technician education are concerned, the Government should take the entire financial responsibility by sponsoring pilot projects and other programmes.

144. At the National level, adequate provision should be made for the evaluation of the entire system to ensure that the money spent is effectively and properly utilised and that proper standards are maintained with regard to the overall national needs.

145. The annual provision under contingencies, materials etc. should be raised to a minimum of Rs. 300/- per student against the present provision of Rs. 120/- to Rs. 150/-. The annual per capita recurring expenditure should be revised to a figure of Rs. 1700/ to Rs. 1800/-.

Acknowledgment

1. We wish to record our gratitude to the Government of India for giving us the opportunity to study the problems of technicians education in this country.

2. We also record our gratitude to the representatives of various Industries, Chambers of Commerce, Indian Engineering Association, All India Manufacturers Organisation, Institution of Engineers (India), State Governments and others for their generous cooperation and advice.

3. Many Principals and teachers of polytechnics and individuals submitted their views in writing or during discussions. We express our gratitude to all of them.

4. We are happy to record our sincere thanks to the foreign Consultants, whose services were kindly lent to us by US-AID, British Council, West German and Japanese Embassies and to Shri G. K. Chandiramani, Educational Adviser(T) and Dr. L. S. Chandrakant Joint Educational Adviser to the Government of India for their suggestions and advice.

5. We owe a special debt to the P.S.G. College of Technology, Coimbatore, the Indian Institute of Science, Bangalore, Indian Institutes of Technology, Bombay and Delhi, Institution of Engineers (India), Calcutta and Council of Scientific & Industrial Research for providing us accommodation for holding meetings and for the facilities.

6. We shall fail in our duty, if we do not thank the staff of the P.S.G. College of Technology, Coimbatore, Technical Teachers Training Institute, Calcutta, and of the Technical Division of Ministry of Education for their selfless and devoted assistance.

7. We cannot conclude our acknowledgement without expressing our indebtedness to Prof. V.K.R.V. Rao for his encouragement and guidance in all our work.

PART II

APPENDICES

सत्यमेव जयते

SPEECH OF PROF. V. K. R. V. RAO, MINISTER FOR EDUCATION AND YOUTH SERVICES, AT FIRST MEETING OF THE COMMITTEE.

On behalf of the All India Council for Technical Education and on my own behalf, I have great pleasure in welcoming you to this the first meeting of the Special Committee for Polytechnic Education. I am thankful to you all for agreeing to serve on the Committee. You are representative of all the interests concerned with polytechnic education-institutions which produce diploma-holders, academic experts who are responsible for the standard and content of the diploma courses and for teaching and also industry which is the main user of technicians.

In particular, I am grateful to Professor Damodaran for agreeing to head the Committee. He is a pioneer in the field of technical education, and has worked throughout his professional life to bring technical education into intimate relationship with industry. His own institution at Coimbatore, as you all know, is a fine example of close cooperation and coordination between technical education and industry. I have no doubt that, under his able advice and guidance, the Committee will produce a valuable report. I am also thankful to Dr. Pran Lal Patel and Shri G. S. Somani who represent the All India Manufacturers' Organisation for agreeing to serve on the Committee. The All India Manufacturers' Organisation has taken keen interest in the development of technical education, particularly at the technician level, and organised a first-rate seminar in Poona, a couple of months back to bring to bear upon the problems of technical education the experience and the viewpoints of industry.

There has been a lot of criticism about our Polytechnics as not being sufficiently practical in their training programmes, and we have discussed this subject on earlier occasions. When I was in the Planning Commission some years back, I made a strong plea for a thorough examination of our polytechnic system and to bring it into a purposeful relationship with industry for training the correct type of technicians. Later, at the last meeting of the All India Council for Technical Education in September, 1969, I spoke at great length on this subject and suggested that the present stage of consolidating technical education was opportune for reorganising our polytechnic courses. The All India Council welcomed the suggestion enthusiastically and authorised me to constitute an expert committee immediately.

Importance of Technicians

We all know how important the middle-level manpower is for the wide range of professional duties that it is called upon to perform. The technician is concerned with the application of known knowledge to field operations in production and construction, testing and development; installing and running engineering plant; drafting and designing products; estimating cost; selling and advising customers on the use of engineering equipment. The technician also acts as a liaison between the engineers and skilled craftsman to interpret the engineer's plans and designs, to determine the type of production and construction techniques to be adopted, and to choose the tools and machines best suited to specific jobs. We must, therefore, evolve a coherent system of technical education designed to train technicians and other types of middle level personnel needed by our industry. In planning for this, however, we must remember that the training of a technician is a long process that takes place partly in a technical institute and partly in industry.

Purpose of Curriculum

The purpose of the technical institute curriculum is not only to impart a sound broad-based theoretical knowledge of a chosen engineering field but also to mould and develop the attitudes and aptitudes of the student towards optimum proficiency and productive capacity for immediate employment. The education given in a polytechnic, therefore, must be cross-fertilised with practical training experience in industry so as to expose the technician trainee to actual working conditions and methods, techniques and skills relevant to his field of speciality in drafting, design and development of products and engineering plants, in installing and operating equipment, in construction, in estimating cost, and so on.

In addition, the trainee must be made to observe and understand how the engineering principles and their applications are translated into practical operations and processes in the design office, on the shop floor and in the field. In this process, he should acquire sufficient occupational competence to be able to perform the same professional functions independently when employed on the job. To coordinate theory with practice, to relate teaching to industrial work and to elaborate the complementary functions of technical institutes and industry-all this is the heart of the technician training.

Our concern should be to develop a system of polytechnic education that articulates the joint and cooperative effort of technical institutes and industry. A purposeful system of industrial apprenticeship that industry, on the one hand, accepts as its primary responsibility and that technical institutes, on the other, regard as an integral part of the total process of education, is our primary need today.

Need for Training

The importance of technicians particularly in a developing country like ours cannot be over-emphasised. In the short run, critical shortages in respect of engineers and scientists can be met by adopting or adapting technological know-how from developed countries and importing capital equipment needed by industry. A shortage of technicians, however, cannot be made good by these methods because the imported technology and capital equipment can be used by the people of the developing countries only when they are adequately trained for the purpose. It is, therefore, imperative for us to train and develop our indigenous personnel as competent technicians. In the last analysis, the pace and directions of the economic progress of our country will largely depend upon how far we are able to solve our technician problem.

Each country has evolved its own technician courses according to the needs of its industry and according to the stage of technological development. There is, therefore, an almost bewildering variety of technician courses in the world that is only paralleled by the wide range of job operations that technicians are called upon to perform. The structure of the courses, their contents and standard and the organisational arrangement for conducting the courses differ widely from one country to another. For instance, there are near-professional courses for those technicians whose work demands a sound theoretical knowledge of engineering. At the other end of the spectrum, there are near-craft courses, for those technicians who need to have mastery of practical skills. In between there are courses that have varying proportion of theory and craft content.

Systems of Training

A variety of organisational arrangements characterises the complexity of technician courses. These consist of full-time integrated courses that are two or three years' long; sandwich courses in which a student spends stated periods in industry and in a technical institution in alternate layers; block release courses, day release courses, evening courses and also correspondence courses. Each type of courses conducted in a particular country represents the historical development of technical education in response to industrial needs.

For instance, in the United States, the wide-spread Technical Institutes courses grew out of the impact of rapid changes of technological, economic and social development in the beginning of World War II in 1939. As the frontiers of engineering knowledge expanded, the need was felt for more and more people who understood how to work in the electrical, aeronautical, mechanical and chemical industries. To meet the demand, two-year full-time courses were organised, extensively for training engineering technicians. Today, these courses have spread so widely that at least one in 30 employed in industry in the United States, is a Technical Institute graduate.

In Britain, the interest of industry in the training of technicians is reflected in a well-organised system of sandwich courses that represent the joint responsibility of industry and technical institutions. Similarly, part-time courses of various types that are offered by a large network of Institutions are typical of the British scene which relies heavily on industry for the training of craftsmen and technicians. Industy provides practical training for four days a week and technical institutions provide the educational content during one day a week. The system works admirably in highly industrialised and highly populated countries where distances are small.

Correspondence courses which are very popular in Australia, New Zealand and USSR are useful wherever students are widely dispersed and part-time and day-release courses are not practicable.

The German system of training "practical engineers" who are greatly valued group of middle-level personnel is unique for that country. Every candidate who joins an engineering school or Technicum to become a practical engineer must have completed at least a two-year apprenticeship in industry and German industry is providing excellent facilities for such apprenticeship training. It is, therefore, not possible to generalise the structure and form of technician courses throughout the world.

Each technician course has its own integrity. As Dr. French puts it admirably: "It is vital that a country about to organise (re-organise) its system of technician education and training should adopt that system (or systems) which is best suited to its particular circumstances, and not simply copy another country's system however well tried and successful that may be. Only if the two countries "match up" will success result from a straight duplication, and examples exist where overseas experts who have endeavoured to set up in developing countries a simple image of their system have thereby done little good and perhaps a positive disservice to the countries concerned.

Progress Since Independence

Since 1947, when India became independent, there has been a phenomenal expansion of technical education at the polytechnic level in our country. In 1947, there were only 53 institutes conducting diploma courses and they admitted 3,670 students each year. The number of diploma-holders trained were less than 4,500 a year. Today, we have about 280 institutions which are capable of admitting about 50,000 students each year. The number of diploma-holders trained each year has jumped to about 23,500.

The total financial outlay on these institutions so far exceeds 100 crore rupees for their campuses, buildings (including hostels), equipment and other capital items. Their annual budget for maintenance expenditure is over 10 crores of rupees.

Today, nearly 200,000 diploma-holders who have graduated from these polytechnics are working in various departments of our economic life. The present student-enrolment is about 100,000 and the faculty consists of over 10,000 teachers.

This is the magnitude of our technical education enterprise at the middle-level. Many important questions, however have been raised about the standard and content of the polytechnic courses, their relationship to industrial needs and the new directions in which the whole system of polytechnic education should be reoriented. It is one some of these aspects that I wish to share my thoughts with you today.

Polytechnic Curriculum

A review of our diploma courses shows that the so-called engineering theory accounts only for about 35-37 per cent of the total curricular time, the rest 63-65 per cent of the instructional time available being devoted to laboratory work, workshop/field work and drawing. Thus, the structure of our polytechnic curriculum provides for at least 65 per cent of the instructional time for practical work in the laboratory, in the workshop or in the field. This compares favourably with similar technical courses conducted by institutions in developed countries. Therefore, the correct position is that our diploma courses do not seem to suffer from an overdose of engineering theory with the inevitable sacrifice of practical work. There is, at the same time, the severe criticism that our diploma-holders are not sufficiently equipped on the practical side. The main deficiency, to my mind, is that instruction given in our polytechnics is not backed with the practical experience in industry that is vital for producing a finished technician fit to enter upon his professional responsibilities in an industrial organisation. This deficiency arises out of the fact that we have not yet organised a first-rate system of apprenticeship in industry in elaboration of polytechnic education.

As I explained earlier, in Germany, for instance, every candidate who wishes to enter a Technicum must have completed a two-year apprenticeship in industry. In Britain, a major part of the technical college programme for the middle level technician is organised on a sandwich basis, in cooperation with industry in which a student spends half the time in industry and the other half in the institution in alternate layers. In India, our industrial organisations and other employing authorities have yet to organise on an adequate scale programmes of apprenticeship for young persons after they have completed polytechnic courses that will condition them as technicians and back up the educational programmes of polytechnics. On the other hand, they demand of the polytechnics that these shall produce technicians fully equipped with practical experience and ready to undertake professional responsibilities. No polytechnic can meet this demand without the active cooperation of industry in organising and conducting an apprenticeship programme as an integral part of the total process of technician training.

New Approach

I would, therefore, suggest for the consideration of your Committee that the reorganisation of our polytechnic courses must proceed in this new direction.

First, polytechnics and industry that are located near each other should cooperate in organising and conducting sandwich courses for training the correct type of tehnicians that industry requires. Some efforts in this direction have been made in certain institutions in Calcutta, Madras, Coimbatore, Bangalore, Bhopal and elsewhere and the sandwich courses conducted by them have proved very useful. I feel that sandwich courses should become ultimately a general principle for all polytechnics which are located close to industry. Industry must accept as its legitimate responsibility the organisation and supervision of training for polytechnic students. Technical institutions must recognise that unless practical training becomes an integral part of the total educational process we cannot hope to produce the correct type of technicians required by industry.

The Central Government has proposed that the Apprenticeship Act of 1961 should be amended to include engineering graduates and diploma-holders. I hope that, when the amendment is passed, it will be possible for sandwich courses to be organised on an extensive basis. I hope your Committee will give detailed consideration to this urgent need and suggest a well integrated and well coordinated scheme of sandwich courses for polytechnics.

Methodology of Teaching

The second criticism of our polytechnic courses is that they are still a poor imitation of our engineering courses. In view of the constant reiteration of this criticism, your Committee should examine thoroughly the curriculum of diploma courses. Apiece with the curriculum is the question of methodology of teaching, how the different subjects are taught, the level at which they are taught and the methods by which engineering theory is related to professional practical work. You must examine the whole process of polytechnic education, the teaching and learning processes, the instructional materials used, teacher competence, selection procedures of students for admission and so on.

Specialisation Technicians

The third criticism of our diploma courses is that they are in the broad fields of civil, engineering, mechanical engineering and electrical engineering, and that there is no attempt at diversification or specialisation in any one particular branch of a major subject-field to train specialist-technicians. This is true, but we must examine the pattern of employment of technicians in the major sectors of our national economy. With the expansion and deepening of our economy, employers in both public and private sectors are now seeking a stronger accent on specialisation.

The stage has perhaps come when our polytechnics in close co-operation with industry should carry out an analysis of the functions, fields of activity and typical job positions available; should identify various technician specialities and should re-organise their curricular offerings to suit those specialities. In doing so, they should bear in mind the pattern of employment in major sectors of our engineering activity, the need for the mobility of the technicians both horizontal and vertical, and the immediate and future employment opportunities available to them.

Before any of these specialities is started as a part of the engineering curriculum, each polytechnic should ensure in consultation with the employing authorities concerned, that there is an adequate demand for specialist-technicians trained by them. Training in each speciality should be a judicious combination of theory and practical experience in the field and, where possible, as I said earlier, the sandwich type of courses should be offered.

The curriculum should give a broad-based education in the major fields of engineering; and training in a particular speciality should be built on the broad-base. We should ensure, that, if the diploma-holder does not get a suitable job in his speciality, he will not become unemployable as a technician in another relevant field, and that his horizontal mobility does not become difficult. Even where sandwich courses are followed, flexibility should be allowed to each institution to decide in consultation with the cooperating industry at what stage of the course the professional practical training should be integrated with the whole educational process. Flexibility should also be allowed to each institute to decide whether the professional practical training should be organised at one stretch or given in convenient instalments at appropriate stages. The integrity of the sandwich course is best maintained by establishing a close relationship between engineering theory and its application to actual construction, production, design and maintenance of plant and equipment.

Training of Craftsmen

There is another important aspect to which we, in our country have devoted little attention and that is, building a bridge between the training of a craftsman and his subsequent development as a technician. As you know, all craftsman training programmes are being conducted at the Industrial Training Institutes under the Ministry of Labour and Employment and the polytechnics conduct diploma courses. There is unfortunately a big gap between the Industrial Training Institutes and Polytechnics, and one is functioning in isolation from another. This unfortunate gap has led to an untenable situation in our country.

Industry requires a large number of craft-oriented technicians who are capable of applying practical skills to production, construction and maintenance, but the structure of our polytechnic courses does not provide for the training of such technicians in elaboration of the craft-training at the Industrial Training Institutes. When we re-structure the polytechnic system, we must ensure that this bridge is built between ITIs and polytechnics. This is urgent particularly in view of the fact that the broad spectrum of technicians requires not merely those who are equipped to perform the near-professional functions but also those who are equipped with manipulative skills for application to production and construction with an understanding of basic engineering principles.

Training of Teachers

Our Plan for reorganising and improving polytechnic education will succeed only to the extent to which the teaching faculty of our institutions are continually trained and motivate for the new task. Unfortunately, the present position in our polytechnic leaves much to be desired.

In addition to a large number of vacancies that persisted for long periods in many institutions, the quality and standards of the teachers available have not come up to the desired level. Though in the last 3-4 years, the vacant posts have been largely filled, and the present shortage does not exceed 20 per cent, the quality of the staff remains much the same. A large number of teaching positions are held by fresh graduates with little or no industrial or teaching experience. Even among the older staff that have been serving the institutions for a long time, industrial experience and contact with the practice of engineering are grossly inadequate.

Tasks During Plan Period

All these and other deficiencies that have retarded the progress of polytechnic education in our country needs to be removed as a top priority. That is the primary task before us in the Fourth Plan and we look forward to the recommendations of your Committee for concrete measures to improve the quality and standard of diploma courses through better teachers.

The four Regional Technical Teachers' Training Institutes that are in process of establishment, are only the first step in this direction. The total faculty strength in all the polytechnics is about 10,000 at the level of instructors, lecturers and heads of departments. The main problem is how to train this large number of teachers and equip them with the necessary competence to make them function better. Even when all the four Technical Teachers' Training Institutes are functioning on full power, they will not be able to produce more than 250—300 fully trained teachers each year. At that rate, it will be 30 years before we train all the teachers now serving in our polytechnics. It is inconceivable that we have to wait so long to build up the faculty of our institutions on an organised basis. Other programmes that can give us quick results are urgently needed. I would like you to consider what types of short-term, intensive in-service training are needed and also relevant practical training in industry.

Polytechnic Students

I have no doubt that the question of polytechnic students will also receive your close attention, for, in the final analysis, it is the student who must benefit from whatever type of education that we can design to meet the future needs of our country. The types of students who are entering our polytechnics, their initial educational preparation, particularly in mathematics, physics and languages, their motivation, their ability to go through the courses satisfactorily and their placement in productive occupations after polytechnic education, and their further development as technicians are all important aspects. We have no adequate data on these aspects of our polytechnic students at present. I am, however, deeply concerned over the high attrition factor among our polytechnic students. According to the information available, nearly 50 per cent of the students who enter polytechnics do not seem to complete the course satisfactorily within the prescribed time. This is a large wastage both in financial terms and in terms of human resources. We must investigate into the whole matter with great care and deliberation.

In these brief remarks, I have tried to touch upon some of the major aspects of our polytechnic education and endeavoured to focus your attention on them. I know that there are many other important aspects that must be considered by you in re-structuring our polytechnic system and preparing a blue-print for its further development for the next 10 years.

Foreign Advisers

The training of technicians and design of an appropriate educational system for the purpose is a world-wide problem. Many developed countries have over the years, worked intensively in this field and gained much valuable experience. We must profit from their experience in the consideration that you are going to give to the same problem in our country. I have, therefore, proposed that we should invite to assist and advise your Committee experts from Britain, the U.S.A., West Germany, Japan and the USSR. I know that you will welcome this proposal and make the best use possible of the overseas experts who will be joining the Committee shortly.

I am glad to tell you that Dr. French, Chief Inspector of Technical Education in the British Government who is a well-known authority on technical education, has agreed to come. He will be joining the Committee in the course of this month.

Prof. Ross Henninger, who, as you know, is the President of the Ohio Mechanics Institute and a renowned authority on technical education in the United States, has agreed to come to advise and assist the Committee.

The Governments of West Germany, Japan and the USSR have agreed to send the best experts available from their respective countries and we are awaiting further particulars about them.

Employment Prospects

In conclusion, I must reiterate the great importance that I attach to the work of this Committee. Unemployment amongst the diploma holders is five times that among the degree holding engineers; and yet as far as the stock position is concerned, the diploma holders are only 1.6 or 1.7 times the number of degree holders. There is thus, no doubt that the incidence of unemployment among diploma holders is much greater than that among engineers. Admissions are also declining at a faster rate in the polytechnics than in the engineering colleges. I have no doubt, therefore, that there is something radically wrong with our system of polytechnic education.

At the same time, there is no doubt that both the needs of industrial development as well as of the optimum use of technical education, we need many more technicians in our country; and it is the polytechnics which have to produce them.

In fact, in the major industrially developed countries, the proportion of technicians to engineers is 5 to 1 or 4 to 1. We, in this country, have set before ourselves a more modest target of 3 to 1.

How can we go about with this when we find so much of unemployment among the diploma holders? It is, therefore, a matter of urgent national necessity that our polytechnics education is set right so that it can be geared up to fulfil the target we have in mind and at the same time see that all these diploma holders get employment as technicians. Hence the importance that I attach to the work of this Committee.

I look forward to your recommendations for reorganising and re-structuring our polytechnic education on a long-term basis and bring it into such intimate relationship with industry to make possible the production of better trained diploma holders, more diploma holders and employment for all of them.

APPENDIX II

PERSONS INTERVIEWED AND ACKNOWLEDGMENTS

The Committee gratefully acknowledges the valuable suggestions and views presented to the Committee by the following:

A. Persons Interviewed

Ministry of Education, Government of India.

- Shri G. K. Chandiramani, Educational Adviser (Technical)
- Shri L. S. Chandrakant, Joint Educational Adviser (Technical)
- Shri S. Sadasivam, Dy. Educational Adviser Eastern Regional Office, Calcutta
- Shri M. S. Srinivasan, Asstt. Educational Adviser, Southern Regional Office, Madras-6.

Directors of Technical Education

- Dr. B. L. Shantamallappa, Director of Technical Education, Mysore
- Shri P. Sivalingam, Director of Technical Education, Guindy, Madras 25
- Prof. G. V. Sapre, Director of Technical Education, Maharashtra
- Shri S. R. Bedekar, Director of Technical Education, Madhya Pradesh
- Shri K. C. Mukherjee, Chief Inspector of Technical Education, West Bengal
- Shri P. S. Kalwatchwala, Director of Technical Education, Gujarat
- Shri J. P. Chowdhury, Director of Technical Education, Bihar
- Shri M. C. Verma, Director of Technical Education, Chandigarh
- Shri N. C. Choudhury, Director of Technical Education. Uttar Pradesh

Representatives of Governments

- Shri T. S. Basur, Representative of the Government of Punjab
- Shri S. N. Goel, Representative of the Government of Rajasthan
- Shri T. S. Murthy and Shri O. P. Sharma, Representatives of Delhi Administration
- Shri S. R. Nayar, Representative of the Government of Haryana.

Industry and Commerce

(a) *Associations and Organisations*

- General Manager, Hindustan Machine Tools Co. Ltd., Bangalore
- Shri M. S. S. Varadan, Chief Organisational Development Hindustan Machine Tools Co. Ltd. Bangalore
- Shri K. Easwaran. Industrialist, President, All India Engineering Association, Southern Region Madras.

Representatives of the Indian Engineering Association, Calcutta.

- Dr. S. C. Bhattacharya of Union Carbide (India) Ltd., Calcutta
- Shri D. N. Mukheree, Braith-Waite and Co., Calcutta
- Shri S. K. Sen, Chief Labour Officer, Indian Engineering Association
- Director, Central Machine Tools Institute, Bangalore
- Shri D. P. Birla, President, All India Manufacturers' Organisation

(b) *Industrialists, Experts*

- Dr. P. J. Bhatt, Consulting Engineer, Bombay
- Shri R. N. Joshi, Bombay
- Shri G. K. Devarajulu, Chairman, Textile Machinery Development Council, Coimbatore
- Shri K. Sreenivasan, Director, South India Textile Research Association, Coimbatore

Professional Bodies.

Representatives of the Indian Engineering Association, Calcutta

- Prof. H. C. Guha
- Shri T. R. Gupta
- Prof. S. K Bose
- Shri N. N. Chakravarty
- Shri S. K. Dutt
- Shri S. K. Majumdar
- Shri S. K. Mukherjee
- Shri S. K. Sur
- Shri D. K. Ghosh
- Shri S. K. Sarkar

Shri T. K. Hazra

Col. B. T. Nagrani

Shri M. K. Raju, President All India Management Association and Director, India Pistons Ltd., Madras

Educationists and Experts

Prof. P. K. Kelkar, Director, Indian Institute of Technology, Bombay

Members of the Maharashtra State Advisory Committee on Orientation of Diploma Courses in Engineering and Technology

Shri D. P. Nayar, Planning Commission, Government of India, New Delhi

Mr. John McGreal, USAID, New Delhi

2. Persons Who Submitted Views and Suggestions

1. Principal, CIT Sandwich Polytechnic, Coimbatore 14.
2. Principal, Dibrugarh Polytechnic, Lahoal
3. Principal, Purulia Polytechnic, Purulia.
4. Principal, Government Polytechnic, Bellary
5. Principal, Valivalam Desikar Polytechnic, Nagapattinam
6. Principal, Government Polytechnic, Nowgong
7. Principal, Government Polytechnic, Faizabad
8. Principal, Tamilnad Polytechnic, Madurai
9. Principal, Kashmere Gate Polytechnic, Delhi
10. Principal, Srinivasa Subbaraya Polytechnic Puttur, Tanjore District
11. Principal, Government Ceramic Institute, Gudur
12. Principal, The Seshasayee Institute of Technology, Tiruchirapalli
13. Principal, Pt. Jawaharlal Nehru Polytechnic, Sanawad, M.P.
14. Principal, Government Polytechnic, Mirzapur
15. Principal, Annamalai Polytechnic, Chettinad
16. Principal, Government Polytechnic, Nagercoil
17. Principal, MBC Institute of Engineering and Technology, Burdwan
18. Principal, New Government Polytechnic, Patna
19. Principal, Northern Regional Institute of Printing Technology, Allahabad.
20. Principal, Hewitt Polytechnic, Lucknow
21. Principal, Murugappa Chettiar Memorial Polytechnic, Avadi, Madras
22. Principal, Thiagarajar Polytechnic, Alagappanagar P.O.
23. Principal, Government Polytechnic, Barauni. Monghyr.
24. Principal, Government Polytechnic, Proddatur
25. Principal, Government Polytechnic, Purnea
26. Principal, Murshidabad Institute of Technology, Berhampore, West Bengal
27. Principal, B.P.C. Institute of Technology, Krishnagar, Nadia
28. Principal, Government Polytechnic, Vellore
29. Principal, Cooch Behar Polytechnic, Cooch Behar
30. Principal, Allahabad Polytechnic, Allahabad
31. Principal, S. V. Polytechnic Bhopal
32. Principal, Thapar Polytechnic, Patiala
33. Principal, Srinivasa Subbaraya Polytechnic, Puttur, District Thanjaur
34. Principal, Government Polytechnic, Batala
35. Director of Technical Education, Rajasthan, Jodhpur
36. Shri K. T. Doshi, Sirohi
37. Shri L. L. Bhirud, Head of the Civil Engineering Department, S. P. College of Engineering, Bombay
38. Shri L. N. Mittal, Lecturer, Ramgarhia Polytechnic, Phagwara
39. Head of the Department of Electrical Engineering, G. B. Pant Polytechnic, New Delhi

Acknowledgment

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APPENDIX III

REPORTS OF THE FOREIGN CONSULTANTS

SECTION I

Comments Concerning, Technical Education in India*

G. Ross Henninger-USA & E. Houghton-U.K.

Introduction

Two months of travel and visitations to institutions of technical education and to industries in the States of Andhra Pradesh, Tamil Nadu, Mysore, Maharashtra, Gujarat and Rajasthan have resulted in the general impressions expressed in the following pages. The selections of institutions, industries, and other bodies to be contracted were made by the official representatives of the various Governmnt agncies involved. It was understood that the objective would be to accomplish a representative sampling.

Throughout our travels it seemed to be assumed by those we visited that more-or-less drastic changes in curricula were all that would be necessary to make Polytechnic graduates more acceptable to industrial employers, and thus provide a correction of a reported trend of growing unemployment among technical graduates. A wide-spread predisposition seems, to prevail among the educator groups that a change-over to "sandwich"-type curricula would solve most, if not all, complaints about the present Polytechnic programme. Opinions differ as to whether such a programme must be of a 4-year duration (3-year Polytechnic plus 1 year of application experience in industrial employment); or can be kept at a 3-year over-all length by eliminating some present curricular requirements and condensing others; or be extended to a 5 year programme.

In all the discussions about the asserted need for producing a Polytechnic graduate more attractive to industrial employers, little if anything was said by the educator-group about the possibility of producing a better qualified graduate through the medium of a better quality of instruction in the Polytechnics and more appropriate teaching methods in both classroom and laboratory. In general, educator comments seemed to assume blandly that teaching quality and methods are above reproach, and sometimes keen defensive resentment was exhibited when this attitude was questioned.

In general, our impression is that the foregoing represents a shallow and short-range approach to the problem of accomplishing competent engineering education in India at either the Degree level or the Diploma level. We believe that there are many other and more significant aspects to the problem, and these we shall endeavour to reflect upon in the following pages of this commentary.

Industrial commentators were essentially unanimous in describing recent Polytechnic graduates as being generally poorly prepared for successful employment—sadly deficient in the ability to make practical applications of the subject-matter of their studies.

Number of Institutions

In town after town we observed capital investment in buildings and equipment in institutions providing similar or identical courses at very short distances apart. This seems to have resulted from the random establishment of private colleges and Polytechnics (now receiving government aid) of State colleges and of Women's Polytechnics, all starting engineering courses. This duplication of scarce staff and of building and equipment resources seems a very wasteful expenditure of available educational funds.

Manpower Planning

It is thought highly unlikely that any accurate forecasts can be made of the number of technicians or professional engineers of various kinds to be required over a period comparable with the length of a course from intake to qualification. This is because climate and economic variations are not accurately predictable. The educational system of India has borne the full responsibility for over or under provision of qualified engineers and seemingly industry, the user of these people, has escaped any commitment and in time of scarcity of jobs is able to be extremely selective. This present situation does not of itself provide an adequate or dependable basis for meaningful evaluation of the effectiveness of Polytechnic education in India. Many other factors are involved.

In many industrial undertakings we noted that the industry has started from scratch within the recent past, and while its requirements for qualified personnel has been very heavy at first, in many instances (and often in the last two years) the plant had reached its maximum size as dictated by site, organizational or market considerations, and hence present requirements for technically qualified manpower are limited to those required for replacement due to retirement or migration.

Attitude to Academic Qualification

Our visitation discussions indicate that the general attitude of the graduates has been, and is, that the mere possession of a degree or diploma entitles the holder to proclaim himself an engineer or technician. This is far from the truth, and it should be made more widely known by the faculties and others that suitable practical training and experience is an essential component of such a qualification. This same attitude has led to confusion with respect to the problem of qualification appropriate to the engineering college and polytechnic teacher. For further observations see this heading.

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*Submitted in July 1970

Professional bodies for engineers and technicians should seek to correct this public misunderstanding by developing and publishing suitable standards of individual capability and performance so that it becomes impossible or difficult for an individual to practice without appropriate qualifications with a strictly prescribed academic and practicing standard.

Staff Qualifications

Staff were found to be all-too-generally ingrowing in the sense that a very substantial proportion of them lack periods of formal academic study to stages beyond the courses they themselves are endeavouring to teach. They also very generally lack suitable, or in many instances any, recent relevant experience in industrial or engineering practice. This is found to be resulting in progressive deterioration of teaching standards and quality. This appealing condition and attitude is firmly believed to be one of the major causes of the fact, and the industry-complaint, that diploma graduate (and degree graduates also) show such a poor initial ability to make practical applications of the theory they are supposed to have learned.

Engineering and management personnel in industry repeatedly said that faculty members of engineering colleges and polytechnics did not visit them; would not accept offers of vacation or other employment experience or training in industry did not seem even to be aware of the officially published Indian Standards covering such things as materials of manufacture, processes, engineering drafting, etc. etc.; were seemingly unaware of established machine-tool technology even in the elementary sense of appreciating speeds, feeds, finishing techniques, etc.; and also seemed unaware of the fundamentals of quality control, tool and product-material technology, or the elements of metrology. We met Professors of Mechanical Engineering who described the work done in workshop at final year level in degree courses as producing parts on a lathe without any attention to feeds and speeds or measurement or finish or cutting-tool technology. Although taking prime time in a degree course, the subject seemed to be treated at less than elementary craft level.

Our observations in many faculty group discussions indicated that a situation of line command existed which led us to the conclusion that neither teachers nor heads of department were encouraged to think for themselves and may not have developed that ability. We doubted therefore whether they were able to teach their students to think. We were astonished that this situation developed in academic situations whereas it did not arise in forward-thinking industrial situations.

Teaching and Learning

Unfortunately the major part of our visitation coincided with the student vacation period so that we were unable to draw any conclusions from talking to students or observation of teaching methods and learning practices. We had to draw conclusions from questioning heads of department, and from the brief study of the examination system and of typical papers when we could get them. In some instances we were able to see student laboratory reports and we also questioned faculty personnel extensively concerning teaching methods, examination procedures, and the grade-point levels at which students are allowed to pass.

From these discussions and exhibits, it seems very clear that the prevailing interpretation of the officially prescribed syllabuses results in classroom and laboratory instruction of a rote-type which encourages the student to memorize what the teachers tell him and to copy facts, figures, and diagrams neatly into note books, mostly without ever really studying or actually understanding much if any of the subject matter. This general tendency is found to be intensified by the unreality of the officially imposed annual examination system with its make-up of memory-searching types of questions and serious lack of queries which would defy the student's memory capacity and challenge his ability to think and to work out reasonable and rational applications of the theoretical knowledge he is supposed to have acquired. The present examination system puts a premium upon a student's ability to remember or to regurgitate facts or descriptions in some one else's words rather than upon a knowledge of the subject and an ability for problem analysis and solving which is the real requirement of an engineer at professional or technician level.

The damaging aspects of this situation are intensified by the astonishing prevalence of scholastic performance grades as low as 35 per cent being allowed for passing. This is a totally unrealistic approach to the objective of producing, through India's educational system, Engineers—Degree or Diploma—capable of even recognizing let alone solving a problem, or making a constructive suggestion for improving an industrial process or product.

The Importance of Teaching Method

The "Problem-solving" technique is the prime essential instructional tool for teaching and learning in the field of Engineering subject matter, whether at the degree level or the diploma level. Its function is to develop in the student from the beginning of his technical education and throughout his educational career the ability to think—to reason—to analyze—to synthesize—to visualize to hypothecate. These are his kit of essential mental tools upon which the graduate—Degree, or Diploma—inescapably must depend for his employment career. The quality of these mental tools and the graduate's facility in using them will determine very largely the degree of success he may expect to achieve in the Engineering field, whether as a Degree holder or a Diploma holder.

The "problem-solving" technique *CAN* and *SHOULD* be used preponderantly by teachers of engineering and related subject matter, whether in the classroom or in the laboratory. One difficulty encountered in the successful use of this technique lies in the necessity for the teacher (and the Department Head, and the Principal) really understanding it and using it as his own natural procedure. Our visitations revealed a very dismally small percentage who would qualify. Even though several faculty members insisted that they were using the "problem method", exhibits examined by us indicated that the "problem sheets" were so replete with explanations, data, wiring diagrams, etc. that anyone not totally blind in both eyes could perform the rote "experiments" without doing any significant thinking, reasoning, analysis, synthesis, or hypothecation. When we questioned the faculty members about this they protested that they were performing exactly in accordance with rules and exhibits laid down by higher authority and that there was nothing else they could do about it. We think this warrants searching investigation and correction.

Another difficulty encountered in the effective use of the "problem method" is the fact that the teacher has to do more work, also. And more work is unpopular with many human beings, including teachers already protected by tenure. Our visitations gave us contact with a few scattered instances of teachers popular with many human beings, including teachers dedicated to their work and quite interested in the superior possibilities of the "problem method" of teaching. But not a sufficient percentage to lend great encouragement for significant general improvement in the effectiveness of Polytechnic education. Principals and Department heads should be encouraged by all available means to get this situation in India's polytechnics corrected—and promptly, for India's youth and India's economy are being damaged progressively.

Practical work in "workshop practice" even in degree courses led to a craft understanding rather than what we would consider to be the engineer or technician understanding or "how" and "why" and the deductive reasoning following observation of machine performance or other phenomena. Too often laboratory layouts and equipments were found to be old-fashioned and conventional bearing little if any relationship to industry's present or up-coming needs. The presence of classroom furniture in laboratories made us suspect that the laboratory programme consisted of whole classes being taken through an experiment with the prime and successfully achieved objective of getting a neatly presented well illustrated laboratory report book rather than the laboratory being the means of learning practical problem solving through good engineering method and thought process. Too often the absence of used test equipment between input sources and output measurement devices in electrical laboratories made us question most seriously whether laboratory exercises actually were done at all. Repeated questionings at laboratory after laboratory brought the essentially universal indication that laboratory students had no challenge of problem or responsibility; that they are required to run to the instructor for check-ups on circuit connections and answers to related questions which should be entirely the student's responsibility in a competently administered laboratory.

In general, the arrangement and selection of laboratory equipment is considered to be inflexible and out-of-date.

Accommodation and Equipment-Use of Library

Wherever we went, money seemed not to have been spared on the provision of buildings for classroom and other purposes including communal accommodation, libraries and on main items of equipment. Good library space was found to be generally available for books and periodicals, and apparently library funds have been available in reasonable amount. However, free student access to books seemed rarely if ever available and timetables were such that we wondered if students were ever able to browse through books and acquire the ability to select and read for themselves and, above all, learn how to use a library in their work.

In one of the rare instances where we found library shelves to be satisfactorily available to students (and faculty) we pulled at random 25 or 30 books on subjects of central importance to Technical Education and found without exception that NOT ONE of them had ever been charged out to a student or a faculty member since the books were placed on the shelves more than ten years ago. This gave us the shocking realization that the thousands of rupees represented in currently authoritative and useful technical books stand as a total loss to all concerned, the students, the faculties, and the Indian Nation which they were supposed to serve.

Visits to Industry

Our visits to leading firms gave us the following impressions:

1. After a very rapid expansion from 1946 onwards and particularly from mid 1950's to mid 1960's the industries visited now seem in general to be consolidating their positions, developing full production capability in plants already built. In some cases there is continuing expansion in capability. But in general the current and foreseeable manpower requirement of these industries is only that required for full utilization of present capacity and for normal wastage and retirement rather than the initial high demand of earlier years of rapid growth.

2. The large industries we saw have achieved a relatively high standard of production competence, plant layout and production methods. Some of the in-plant industrial training school we saw are of an extremely high competence and could well be studied by college and polytechnic academic staff.

3. Several of the managers and training officers we met have a sound and deep knowledge of good educational policy and of effective training methods and could very well be consulted by India's educational planners.

4. The country now has an enormous glut of manpower at all levels from lower graduate to unskilled. (The shortage may be at the higher graduate level but since this was not within our brief we have not studied it). Consequently industry is able to be highly selective in manpower intake and has little if any problem of labour relations. It has need of supervisory and management skill only because of the economic need to keep down labour turnover (for conservation of training investment) and to control labour cost. Supervisors and managers did not seem to be aware of the meaning or need of supervisory or management education. Some however recognized that study of communication and liberal arts was a necessary part of technical education as much as the technical subjects since job effectiveness at all levels depended as much on human relations as technical skill.

5. Notwithstanding the comments of Item 2 above we saw little evidence yet of sophistication of product, or production method or process. We saw good conventional machine tools, oileomatic and hydraulic controls and mechanisms, forming by conventional foundry or forging or cold working. However, computers, controlled-machine tools, electronics (especially transistorized or solid state), job transfer machinery, even mechanical handling, control systems, explosive or other sophisticated methods for forming or for material removal etc. were not in evidence. Fabrication was less used than casting or forging. Design for economy of weight or for aesthetic reasons did not seem well developed. Single or batch production was commoner than mass production. The use of plastics and materials has not yet replaced conventional materials presumably because such materials have to be imported. These foregoing items are but random suggestions of the many areas where engineers of superior quality—at both the degree level and the diploma level—are needed to put their minds to work on the up-dating and quality improvement of India's industrial processes products and services to make them more effectively competetive in world markets and more effective in meeting India's internal needs

College Curricula and Syllabus—Timetables

There are some exceptions, mainly in the larger centres, but broadly syllabuses, curricular content, and timetables seem to be centrally imposed by state officers or committees or university academic boards. The teacher seems to have only the job of conveying chunks of information to the student so that he is able to sit for prescribed external examinations. The curriculum and syllabus content is often conventional similar to a pass degree courses of early 1930's in the UK or a watered down version for the diploma. Regardless of the fact that industry seems to be concerned with production and sometimes modification rather than origination of design, design subjects rather than production engineering subjects predominate.

We commonly found topics typical of 1930 syllabuses, such as theory of steam, oil and gas prime movers and rotary converters; thermionic valve circuits being given full treatment and time allocation. More up to date topics and treatments were found generally omitted, to the dis-advantage of the student with respect to his ultimate employment and advancement. Our observations indicate that educational administrators still assume that all students will have come in from the villages and need to be familiarised with elementary metal-working and wood-working, even in the big cities which are full of bicycles, motor transport, modern buildings, and shops full of electrical equipment and metal and plastic gadgets of all kinds. We believe that the prevailing emphasis on this rudimentary craft training in engineering courses—both degree level and diploma level-represents a serious wastage of time which could be spent to much greater advantage on legitimate technical subjects and related problem-solving. We find that it is common practice to offer courses of from three to five or more years duration, with no provision for any intermediate award. Thus, if a student cannot survive the extremely arduous pace he falls away with nothing to show for his endeavour. We believe that this matter deserves study and appropriate corrective action.

We find that quite generally both industry and engineering education institutions at both degree and diploma level profess a serious interest in the upgrading of their respective personnel. However, we find also that the usual approach to this situation is seriously unrealistic and contains inherent characteristics which lead inevitably to a low level of achievement of objective. For example we find that commonly there is a 48-hour 6 day working week in industry and a 42-hour programme of class contact in educational institutions. Thus, there seems to be no time left for the student to think, to learn, to read, to develop a balanced interest in people and social surroundings, or even to develop a healthy body round a healthy mind. Yet both the Degree graduates and Diploma graduates are supposedly destined to become supervisors and managers who need to get the best out of people, who need to assess demand for products and designs and who need to be able to cause people to work effectively.

The worst example met of this was development of a part-time course for Diploma at one of the polytechnics visited. The whole of the full-time course had been spread over seven years (with no intermediate award) requiring at least two hours per day seven days a week, this on top of a 48-hour working week and plus very considerable travelling time. Not unnaturally after 3 years of operation the intake of 120 has dwindled to 55 or less. One wonders what possible use to anybody will be the handful if any of over-worked students that may emerge after the full course, and whether anybody has counted the cost to the state finances and to public health and morale.

The Matter of Professional Recognition

It seems unfortunate that, in the initial effort to establish an educational programme to produce engineering technicians, a bifurcation was established in the field of engineering education by the use of the concept of "Degree Engineer" to identify the graduate of a full engineering college course and "Diploma Engineer" to identify the graduate of a shorter and less sophisticated Polytechnic course. A much clear distinction would have been to designate the Polytechnic graduate as an "Engineering Technician".

Several difficulties are inherent in the present system, of which the following are examples:

1. Both the "Engineer" and the "Engineering Technician" deserve individual identity and parallel recognition as co-participants in the "Engineering Team" concept of modern technical manpower classification. With the present system the "Engineer" is confused and justly annoyed, and his status is confused in the public mind; and the "Technician" automatically becomes a second-rate engineer and hence in effect a second-class citizen whose status is much in question in the public and professional mind, and in the minds of potential employers. This does an injustice to the legitimately qualified "Engineering Technician".

2. The practice of using a common faculty to teach the Engineering student in an Engineering College and also to teach the Technician Student in a Polytechnic results in damage to one or both groups of students and lends strong credence to the general belief that the Technician or "Diploma Engineer" is nothing but a "Watered-down Engineer". The practice of transferring Engineering college dropouts to Polytechnics also contributes a degrading influence.

The quality and level of instruction should be the same for the Technician student in a Polytechnic as it is for the Engineering student in an Engineering College, BUT the scope and balance of subject matter and the direction of emphasis should be distinctly different. Much has been published on this topic and hence it will not be enlarged upon here. (See also "Teaching Method" in this commentary).

However, it is believed that serious study should be given to dropping the "Diploma Engineer" designation for the Polytechnic graduate and establishing the Polytechnic award as an "Engineering Technician Diploma", or some equivalent and accurately descriptive nomenclature. The word "Engineering" is used only as an adjective of which other examples might be "Electrical Engineering Technician", "Mechanical Engineering Technician", "Civil Engineering Technician", "Electronics Technician", "Telecommunications Technician", "Automobile Technician", "Chemical Technician", "Medical Laboratory Technician", etc., etc., The same system could be applied to technician education in fields other than engineering, and result in some desirable consistency which would help in public understanding.

Recommendations

1. Industry should be committed to and be responsible for forecasting its manpower requirements in the various categories required in the years ahead. Correspondingly, the Engineering Colleges, both Degree and Diploma, should progressively become more selective in the quality and quantity of their intake.

2. At every administrative level, from the areas served by an individual Polytechnic to the National area which is the responsibility of the Ministry of Education, immediate and continuing effort should be made to establish and to maintain a close collaboration and intimate cooperation between Industry and the educational institutions. The objective of this would be to bring about by direct interchange at the operating level a better mutual understanding of problems and potentialities relative to the competent development and effective utilization of qualified technical manpower, and to provide the means for effective joint efforts toward better results. This would be to the substantial benefit of all concerned—student, graduate, faculty, employer, and the community at large, locally and nationally.

3. Professional bodies of acknowledged standing should develop and get public acceptance for standards of academic learning, practical ability, and experience for the practising Engineer and for the Technician. This effort should be a joint one and should include industrialists, technical educators, and professionals practising in the various engineering fields.

4. Industry and the professional bodies if appropriately established, should be involved in and committed to direct and appropriate participation in the establishment of policies relevant to the size of intake, selection of students, and the development of training programmes related to and if possible integrated with education curricula wherever such integration is mutually beneficial to all concerned including the students. Such bodies also should be encouraged to provide teachers and practical projects for educational institutions.

5. A closer collaboration and continuing coordination should be brought about promptly among the several Engineering Colleges and Polytechnics existing in any urban area or other appropriate proximity. Much benefit could result from faculty interchange of ideas, discussions of common problems, and in many instances through joint use of specialized facilities, or by consolidation of selected specialized classes, etc.

6. To provide a critically needed facility for immediate and continuing evolutionary development of Engineering Curricula-Degree and Diploma—to keep pace with the ever-advancing technologies, a limited number of educational institutions should be selected from among those already nearest to a desirable standard of quality and competency. These institutions should be charged with the responsibilities and appropriate autonomy for developing appropriate new courses and modifying or eliminating old ones. Those institutions should have residential facilities and be situated conveniently close to industries which are the

most forward-thinking in technical development and in personnel training.

7. It should be a requirement that the faculties of these institutions should have educational qualification at least two years above the standard to which they will teach, and should have recent, adequate, and relevant industrial experience. It should be a requirement for continuance of service that this experience should be progressively renewed by continuing research and development in association with industry or by frequent periods of industrial employment, or both. Facility should be set up for all staff, but particularly heads of department, to spend periods abroad either in education or in industry.

8. The Principals of these institutions should have major participation in the academic governments of colleges of teacher training concerned with pedagogical improvement of technical teachers. Allowance for proper staffing etc. should be made and it should be required that faculties of those selected institutions, including department heads, will attend the teacher-training college or institutes on such repetitive schedule as may be necessary to achieve top-level qualifications and teaching performance. Also, the principals of these selected Polytechnic institutions should be actively concerned with continuing follow-up and assessment of the teaching performance of their faculties. Principals should be charged with responsibility and authority to make such faculty changes as may be required for achievement of substantial upgrading.

9. As soon as these selected institutions have cleaned and up-dated their faculties and correspondingly revised their facilities and teaching methods, they should be given maximum responsibility and commensurate autonomy for devising curricula and syllabuses, and for establishing and administering methods and conduct of assessment for an appropriate award. These selected institutions not only could make early and critically needed contributions toward the development of better qualified graduates, but also could serve as prototypes toward which other institutions might seek to develop in accordance with local conditions and circumstances.

10. It should be borne in mind that the product of the educational system will be in responsible controlling positions in industrial development and professional activity at a period of 10-15 years after the college entry. Thus it is necessary that curricula, syllabuses of education, and technical training should be aimed at the state of national technology to be expected in that advanced period. This requires progressive updating and continuing assessment of educational programmes and policies.

11. With specific reference to various suggestions heard promoting general changes, such as "Diversification" or intensified specialization, or other broad and general changes, our reaction is strongly negative. As indicated throughout this commentary, we recommend general improvements in methods and quality of instruction. Where specific changes are to be considered, they should be searchingly evaluated in advanced and adopted only if circumstances then seem to warrant adoption and only if proper and competent implementation is firmly established and provided in advance.

12. With specific reference to the much-discussed "Sandwich Couses" idea, we strongly recommend that such be adopted only after specific study-in-depth at any proposed location conclusively indicates feasibility, and then only under the following several conditions:

a. Where there is a relatively high and extensive concentration of applicable industries.

b. Where substantial active support and participation by appropriate industries has been pre-arranged well in advance, and definitely committed.

c. Where the participating industries are committed in advance to furnish properly instructive programmes, and to provide a system and competent personnel for the necessary supervision, instruction, and progressive evaluation of each trainee.

d. Where the institution shall be committed in advance to furnish a competent and interested faculty member to serve full-time in the plant with each group of at most 20 students to act as coordinator, counsellor and instructor—and, incidentally to learn for himself about industrial problems and practices.

e. Where satisfactory allowances are committed in advance by the institution on behalf of both faculty member and students to assure a reasonable timetable and work-load properly in keeping with effective learning processes and normal social amenities.

13. Industry has need of craft-oriented technicians. This need will increase as the character of Indian Industry changes with the increased sophistication of products and manufacturing processes. Industrialists told us that they preferred to up-grade their more experienced craftsmen than to employ and train polytech graduates. They accomplish this at present by in-plant training. It is thought that many of the present polytechnics would do well to turn their attention to serving and assisting neighboring industry in this direction.

This commentary embraces the substance of what we consider to be the more important matters which have come to our attention. It is respectfully submitted to the Ministry of Education through Mr. Damodaran's Committee in the hope that it may be of assistance in the further development and improvement of engineering-related technical education in India.

Sd./-	Sd/-
G. Ross Henninger	E. Houghton

New Delhi, India.
15th July, 1970.

SECTION II

FURTHER COMMENTS*

E. Houghton U.K.

I would like to begin by expressing my cost cordial thanks to the very many people who have made me feel so welcome in this country and have taken such pains to educate me and facilitate my task. Everywhere I have been most cordially received and time and trouble have not been spared in making me welcome and showing me far more than I could possibly digest.

In making my contribution, I may be more often critical than offering praise. I do this as I normally do in similar assignments as one of Her Majesty's Inspectors when I am operating in England and Wales, because it should be well understood that I seek only to better the whole system I am studying and to offer advice to those charged with the responsibility for the public service which will enable them to identify the problems and arrive at a good solution. I trust that the Indian Government Committee which I have served in the last few months will read my report in this light. It will be for them to say whether any of my observations are generally true or false and to make recommendations to Government accordingly.

In July 1970, G. Ross Henninger and I made a joint statement to a meeting of the Special Committee held in Bombay. After that meeting Mr. Henninger left India and I have since made a further study in some greater depth at selected centres at the request of the Chairman of the Special Committee, Professor Damodaran and Shri Biman Sen and Shri Narasimham of the Ministry of Education and Youth Services. After this further study and after longer time for careful consideration, I do not feel a need to make any amendment to the joint statement on the existing situation or the Recommendations Nos. 1—13 which we then made. This further statement will be in the nature of an amplification, will introduce a few fresh observations and will include as annexures some specific observations on particular topics in response to the request of the Chairman.

I propose to make this further statement under the following headings:

I. Important Steps in Reorganisation
  1. Scaling of Provision
  2. Staff Development and the TTTIs
II. Some Further Random Observations
III. Underlying Causes of Defects in the System-Incentives and Disincentives

Annexure A Industrial Training Boards in UK
Annexure B Electronics and Telecommunications

I. Important Steps in Reorganisation

I make this my first heading in an attempt to isolate, from a welter of observations and recommendations, the steps which will need to be given first attention in order to make reorganisation a reality.

1. *Scaling of Provision* to assess the size of the task and feasibility seems to me an obvious first step and it is for this reason that I am perhaps risking repetition.

I think it is essential for the educational service to work with and involve industry in specifying the number and quality of technicians required. Appropriate professional bodies should also be concerned in specifying quality. In specifying numbers, some regard should be paid to the excess required over and above those forecast as required by present industry, *i.e.* those required for national development and expansion, for enterpreneurship etc.

I also think it is important for the educational service to look realistically at the number of institutions required. In a situation where there is an acute shortage of quality staff, it is totannly unrealistic to maintain full staffs in small institutions remote from the industries and bodies of enlightened thought in the advanced disciplines of engineering. It is not necessarily sugggested that individual courses should enrol large numbers since there is great advantage to be derived from close contact between a small group of students and a well qualified tutor. Pilot courses are also better if groups are small, so that they are within the capacity of available placements of laboratory and industrial experience. None the less, these advantages disappear unless the staff is of high quality and the placements are suitable and well organised. Much greater benefits derive from having a concentration of expertise and facilities on one campus. The more important advantages are that expert staff and facilities are available to a wider range of courses, the liaison with industrial management is simplified and not aborted by overloading the management of industries with educational contacts; students gain enormously from the interchange of ideas with students of other disciplines or with students having industrial experience who come back to college for updating or postgraduate study. Most important of all, the expensive and rare staff such as good principals, heads and senior lecturers, the library, laboratories and workshops with large expensive equipment, can be more fully loaded.

Submitted in September, 1970.

If colleges are to be maintained in small towns away from major industries, then they should offer courses appropriate to the needs of the local community. Otherwise they take people away from the countryside and send them to the major centres, where they will become dissatisfied and dissident, since they have been ill-prepared for industrial engineering employment. The rural communities need to be encouraged to prepared progressive young people to develop farming and rural industries on progressive lines. Young people who are going to leave the village for industrial or commercial life in the cities would be much better served by pursuing their education and training in major centres where they can receive high quality education and training and become accustomed to the faster pace of the modern industrial or commercial centre.

2. *Staff Development* is I believe the hinge-pin of successful reorganisation.

I think it is a necessary assumption that the present force of teachers and heads will be called upon to implement all the changes in college organisation and philosophy, curriculum development and teaching method. The task of retraining and developing this force is an immense one and priorities will need to be settled so that the task can be completed to a reasonable time scale. It is not a once and for all task, since continuing development and improvement will be necessary as or demands on the system change and in the interest of continuing improvement in efficiency.

Because of the size of the task and because training is rarely effective without follow—up and support on the job, I believe that it is a task to be shared between many agencies. There is need however to have focal points or central units which will act as spearheads for training and which will conserve and unify effort so that there is maximum and speedy effect.

I believe tht the Technical Teacher Training Institutes could have a most important and vital role to play and could become the focal points or spearheads of all training activities.

To intiate programmes of staff development and training, a start should be made with principals since they will need to carry through the reorganisation and to be the agency which ensures that teaching staff follow programmes of training and make use of their new skills. For this reason it is urged that the principals of contributory colleges should have a major share in the academic governance of colleges of teacher training or at least should form advisory committees for these colleges.

Since the TTTIs will have such a major role to play the direction and governance of these institutions and the staffing and provisioning should be given the highest priority so that personnel of the highest calibre available are engaged in planning and executing their activities. There is need to co-ordinate the activities of the TTTIs with the activities of external and other agencies engaged in staff development so that a common purpose is pursued towards maximum and speedy effect.

Recommendations 6-9 in the report I submitted jointly with Mr. Henninger proposed the designation within each major region of the country of certain ploytechnics to act as centres of excellence, for which purpose they should be given a higher standard of staff and equipment and a greater measure of freedom in respect of curriculum and examinations. I now wish to suggest that the major role of TTTIs lies first in assisting these designated ploytechnices to perfrom this role and secondly in acting as a medium whereby this standard of excellence should set a pattern for the others.

They would perfrom this work in a variety of ways: by maintaining a cadre of high level specialists who would be available for advice and consultation; by organising both long and short in-service courses for serving staff in the methodology of technical teaching, the use of educational aids, and in the introduction of new aspects of teaching. They would provide the central point of reference for curriculum development and for the preparation and production of teaching materials including books, teaching aids and equipment.

It is observed that in the recent past the TTTIs have offered a long course in three parts. That it has been a long course is considered a major disincentive to the active participation of the teachers who are most in need of training, involving as it does separation from the family and extra cost at a time when there is the heaviest demand on the family budget. Moreover, it is seriously doubted whether the TTTIs are the best agency to execute two of the parts of the present programme—namely, (a) the updating and advancement of subject knowledge and (b) the arrangement of industrial exeperience. The TTTIs may well be the appropriate institutions for researching into and developing methods of implementing these parts (a) and (b) and could well run courses for principals and others who are going to implement these parts locally. It is considered, however, that teachers undergoing these necessary programmes of gaining industrial experience and improving their subject knowledge should not be attached to TTTIs for the following reasons:

(i) In fast moving technologies such as control systems and electronics and in each and every specialist technology the TTTIs cannot be expected to have specialist professors or the necessary equipment and facilities. The Institutes of Technology, some engineering colleges and the research and other institutes such as CMTI should make the major contribution and in some cases the teacher can work for the award of a higher degree.

(ii) Reference will be made later to the need to reduce the number of people taking up the valuable time of industrial executives and others in arranging and supervising training programmes. The matters of arranging successful industrial co-operation is very dependent on establishing goodwill and personal relationships with executives and managements. Too many people approaching managements can destory goodwill and successful co-operation.

(iii) Much travelling time and cost is wasted to the detriment of production time in staff of TTTIs arranging and spervising the training of teachers at a distance throughout a region. It is suggested that the polytechnics and colleges will need to have industrial liaison officers to arrange and supervise industries training and that the polytechnics, either singly or in groups, should have senior staff allocated to work with the TTTIs to act as tutors at the polytechnics and to follow up and supplement the training given at TTTIs.

By freeing the TTTIs from these commitments, which have restricted their influence to a relatively small number of teachers spread widely over the country, we would allow them to concentrate their influence in such a way as to have a critical effect on a selected number of key institutions, and establish a pattern of excellence which could eventually affect the country as a whole.

The TTTIs should concentrate on pedagogical training and the development of socialogical and administrative studies for polytechnic and engineering college staff. It is essential that the pedagogical element should remain technology oriented and all the activities of TTTIs should be oriented to the specific needs of teachers in technological and sociological adult and post school education.

Wherever teachers are encouraged to use teaching aids and materials it should be ensured that these aids and materials are readily available in India. If they are not available but none the less necessary, then it is suggested that the TTTIs should take the necessary initiatives towards arranging for development and manufacture so that this is done at one most economic and speedy centre.

II. Some Further Random Observations

There is much concern about student unrest, not only in India but all over the world. Unrest among any community may be fomented but fomentation cannot be successful in a clear ambience. It is unlikely that human affairs can be so perfectly administered that complete clarity is even achieved and while clarification should be the main aim, some equally effective counter-fomentation will be necessary. Today's unrest among the young is evidence of earlier maturity.

Awareness of social maturity and the need for good personal management is not seemingly well developed in the educational system. A curriculum of up to 40 hours a week of instruction in almost purely technical subjects does not produce an educated man. It can have the opposite effect of producing an automation who is so dulled by drilling in technical data that he is unaware of the real management issues. Large successful firms in the UK who spent considerable effort in developing technical training schemes for craftsmen discovered that these trainees were still ineffective even in the narrow sense of maintaining a high productivity. These firms have now recognised that the greater need is for the sociological education of their employees.

To apply the above to the reorganisation of polytechnic education means that curricula need to be revised to devote less time to class and laboratory teaching in technical subjects; this implies the need for greater effectiveness of teaching in the reduced hours and to allow more time for student corporate life and other means of developing young people as whole well-balanced persons able to face not only the technical but also the social challenge of industrial responsibility. It also means a development of academic staff more aware of their social responsibilities and devotion to the development of whole student interests and very keenly alive to student thought so that at least they can sense and act quickly to eradicate root causes of unrest or indiscipline. In the ultimate however one would strive to attain a condition in which unrest or indiscipline did not arise. It is of course essential to this development of staff that their own selection and administration should be of high order and that they should be supported in their efforts by their governments.

Linked with the above, I would want to make an observation on what I consider to be a common misconception. It is repeatedly said that the diplomate of the polytechnic is intended and recruited by industry to become a supervisor. The supervisor's job in industry seems to be conceived as one of giving orders or intructions for work to be done. It seems to be overlooked that the giving of orders is an interaction between persons or that the real job of the supervisor is to motivate a group of people to work towards a common end. A man can be a good engineer, a good technician or a good craftsman or workman without having any of the qualities which make him a group leader. The selection of leaders with these qualities, education to develop these qualities and training to perform leadership well or in the use of management tools is quite separate from the selection, education and training of engineers, technicians or craftsmen. This needs to be recognised and the whole structuring and implementation of management selection education and training conceived as a separate faculty. Generally, management and supervisory education is a postgraduate of a postappreeiceship study, since maturity in the job situation is a necessary entrance requirement. None the less, since engineers, technicians and craftsmen are members of a working team and of society and some are potential supervisors, there is need for liberal education and some study of administration to be a part of all curricula and in some courses it may be the major part.

It is appropriate here to refer to the commonly held view that part-time courses should be in the students' own time. It is most strongly urged that industry should be persuaded to give release for education and to recognise that tired people cannot benefit from teaching, that free time is learning time, that it is learning that matters not teaching and that further education will often replace and be more effective than works training. Industry would never consider asking employees to return to the works outside working time in order to receive further training. Moreover, the opportunity to attend evening classes at college is only really open to those living within easy access of the college. Colleges are often some miles away from home and workplace.

III. Underlying Causes of Defects in the System Incentives and Disincentives

I have left this Section to the end because I realise that it may be the most difficult and intractable of solution. Also it enters fields in which I am not necessarily expert and there could well be larger issues involved which over-ride the very narrow view which I have taken.

However, my further thinking led me to the conclusion that it was necessary to seek out the fundamental underlying causes of defects in the system. These defects in the system of technical education seem to be already well known by all concerned with the system and after Mr. Henninger and I had prepared our joint statement we observed that we had come to the same conclusions as other various committees and visiting experts in a period 1961 to the present time. I have come to the conclusion that further recommendations and plans for reorganisation will be of no avail unless the underlying causes of disappointing results attending the efforts of staff, heads of departments and principals are recognised and unless determined efforts are made to eradicate these causes. Consequently I have questioned repeatedly at all levels *i.e.* State Directors of Education, Principals, Heads of Departments, Lecturers. I find that while answers vary from state to state as might be expected, it has been presented to me from innumerable reliable sources that there are well defined disincentives in the administration and conditions of employment which are truly at the root of most if not all of the defects in the system. I will therefore deal with this question of incentives and disincentives since in education more perhaps than in any field of human endeavour—success ultimately depends on the morale and conviction of individual teachers and those in positions of academic responsibility. It is likely that I have not uncovered all the factors and I would suggest that a further thorough-going investigation by a team of impartial consultants drawn from all the States, of Indian nationality and unimpeachable professional integrity would be of inestimable value in making a dynamic forward step towards increased effectiveness of the system.

Firstly, I would define the system as not only the polytechnic system of technical education but also the Universities and Engineering Colleges and the Industrial Training Institutes. While I have concentrated on the polytechnics since this was the brief of the Special Committee, I believe it would be a mistake to reorganise and improve the polytechnics and to leave the engineer and craftsman producing system alone, since on the one hand the standard of the professional engineer should be at least as good as that of the technician and likewise there is no real well-defined margin between craftsman and the range of technician employment. All parts of the system can benefit each other and the output of engineers, technicians and craftsmen must work as a team.

Some colleges I have visited, and perhaps many colleges throughout India, have clearly recognisable good staff, equipment, facilities and expertise and high potential. Too often however some factor or factors is or are preventing the college authorities from offering a course and an educational qualification which is real and significant in terms of the quality of engineer required to develop the industry of India or engineers who will exercise individual initiative towards supplying the community with readily available engineering aids to greater prosperity and well-being. Too many other colleges are content to sink further and further behind and do no more than be content with going through the motions of enrolling students, taking classes, conducting terminal examinations with seemingly little thought for the value or betterment of the end product. I will now examine the possible causes of this in Sections 1-5 below:

1. My first observation concerns the system of colleges affiliated to universities, but the same remarks are applicable to colleges within a state operating a State examination. Taking the affiliated college as the example, unless the staff of the college have a strong voice in the academic governance of the university and even when they have, attempts by one college to improve curricula, syllabus content or examination quality are thwarted by other colleges or interests who say that the group of colleges have not all the necessary finance or facilities to make it possible to change. To overcome this problem I would like to give a few observations on the operation of the Council for National Academic Awards in the U.K. I am not suggesting that herein lies a ready solution for India—rather I suggest that the mode of operation should be studied in case an Indian solution can be devised from some of the facets.

In the U.K. the academic independence of universities has been sacred and there was much discussion and controversy in the 1950 as to the form of qualification to be awarded in colleges in the Local Authority Sector after a technological course at first degree level. After a period when the NCTA was set up to award a Dip. Tech. and this qualification had won esteem and recognition the NCTA was replaced by CNAA which would award first and higher degrees not only in technology but also in Arts and Sociological disciplines (B.Sc., B.A. and Masters and Doctorates).

The CNAA has a charter to award degrees and has formed a number of subject panels. The membership of these panels embraces university staff, staff from colleges (which award the Council's degrees), representatives from industry and business, and from the appropriate professional and national educational bodies. There is now a clearly recognisable modus operandi. Firstly, the Council has been extremely careful that the new penny of its degree shall be at least as valuable (some would say more valuable) than the existing degree currency value. When the necessary financial sanctions have been obtained, a college will put detailed proposals to the Council. After consideration of the written scheme and supporting evidence, a visiting panel of the CNAA will assess in depth whether the academic governance, the quality of thinking on the part of individual staff members, the accommodation, facilities and equipment of the institution, the arrangements for assessment and external moderation are such that the course and final assessment of the college can lead to the award of the CNAA degree. If the Council are satisfied then the college is approved and left to operate the course and make awards usually for a period of five years. After that time the approval will be renewed or withdrawn after a further similar investigation by the Council.

I would repeat that this may not be the solution for India and perhaps some other system such as the accreditation scheme of the American Society for Engineering Education or some other system would be more favourable. The important thing is to provide incentive for the elevation of the quality of qualification and to give the maximum autonomy to the college while retaining adequate control over maintenance of minimum standards. It will be noted that in the CNAA system financial control is exercised by the education authorities prior to and concurrently with the academic control exercised by the CNAA.

2. Colleges are constantly under pressure to admit students according to quite arbitrary and often low-quality entry requirements; there is similar pressure to promote or give the final award to students who have not made satisfactory attendance or performance. The motivation for this pressure is doubtless to give better opportunity—the result is sometimes the opposite since it destroys people and commits them to frustration. I would illustrate this by quoting a senior executive of a large undertaking. He said, as many other industrialists have said, that they were quite content with the quality of intake of graduates and diplomates since they carried out their own training (he did not say at what cost), after being able to select an intake of only 5 per cent from the new graduates and diplomates who applied. No industry could afford to consign 95 per cent of its production to the scrap heap. The pressures to increase input and output without regard to quality should be firmly resisted.

3. College staffs once employed at assistant lecturer level can normally expect to rise to senior level according to seniority only. Where selection is made there is sometimes suspicion that the selection is by other considerations than merit. Unless opportunities for promotion occur because the system is to expand (and it is not thought that it should expand) there is little incentive for staff to improve their teaching or develop the college facilities. It is strongly recommended that means should be devised for recognising good performance, satisfactory completion of teacher training or industrial experience, work in the development of teaching or teaching aids; work in the selection and placement of students, work in the development of college corporate life, or in student guidance. It is suggested that promotion from grade to grade should be by selection, taking account of merit on any of the above considerations. The selection procedure should be beyond suspicion and recommended by carefully-appointed committees with membership predominantly of educationists and industrialists with experience of personnel management, if necessary drawn from areas other than that in which the appointment is to be made.

4. While it is necessary to retain democratic control of public expenditure, there is need to ensure within broad limits of control, that the authority of principals and Heads in academic matters and in necessary maintenance of staff or student discipline is not easily over-ridden because, if it is, the whole system can be undermined to the detriment of continuing effectiveness.

5. There are some unfortunate consequences arising from the separation under different Ministries of the I.T.Is which produce craftsmen and the polytechnics which produce technicians. The margin between technicians and craftsmen is not easily defined, both I.T.Is and polytechnics are concerned with efficiency of instruction, both need close relationship with industry and busy industrialists do not welcome duplication of discussion with outside bodies, the polytechnics and I.T.Is can both benefit from an interchange of experties and facilities and for many people in engineering there is need for natural progression from craft to technician employment. The unfortunate consequences of I.T.I. and polytechnic separation should be recognised and continual active steps should be taken to reduce the frictional interface.

ANNEXURE A

Dissertation on the operation of Industrial Training Boards in the U.K. and their relationship with Technical colleges—seen from the point of view of relevance to India. Prepared at the request of Professor Damodaran.

One should first look at conditions in the United Kingdom prior to the passing of the Industrial Training Act in the mid-1960's. From the 1920's and earlier, the largest firms, particularly those employing engineers, had established training schemes, had training officers at a senior level and operated training schools as well as arranging on the job training. During World War II there was considerable development of training facilities, in the services, in civilian industry and under the Ministry of Labour. The nationalised industries such as National Coal Board, Electricity Boards, had well established training schemes. Trainees were recruited from Universities and Colleges of Technology, from Schools and also adults.

The professional bodies such as I. Mech. E., I.E.E. laid down firm standards for admission to membership *i.e.* a specific period and type of:

(a) practical workshop experience.

(b) responsible experience and also.

(c) a specific educational requirement.

Technical Colleges offered courses which in the 1950's were almost entirely day release and post 1960 increasingly block release or sandwich. Major colleges divised sandwich courses in conjunction with industry; sometimes the initiative came from an industry in need of particular kinds of engineers. The typical technical college in the U.K. will offer courses in engineering, business studies, construction, sciences and perhaps mining, printing, or textiles according to the locality. Courses will range in level from degree or professional through technician to craft or operative. In construction particularly but also to an extent in engineering, the craft course at the technical college would deal with the how, why and method of the craft and leave the apprentice to develop skill and speed at work either by organised training or by working with skilled men. Many colleges developed full-time courses at first and second year craft level in which both the educational and training components were given, the latter in the college workshops. At technician level City and Guilds courses were well established in mechanical and electrical engineering and the national certificates were becoming recognised more as a higher technician qualification than as a route to professional status. The Institutions of Mechanical and Electrical Engineering had published recommended forms of practical training for the professional engineer. This was the situation when the I.T. Act became law. The intention of the Act was to make training provision more universal among the smaller industries as well as the bigger and in all industries and commercial situations including retail trades, in various textile industries etc. The Act empowered Training Boards to be set up, to finance themselves by charging a levy on industry, to prescribe schemes of training and to pay grant to employers in respect of training which satisfied the Board's requirement. Schemes of training would not be approved unless at least the equivalent of one day a week release was given for associated further education. Boards were set up to administer training in groups of industries according to the Ministry of Labour Classification. This meant that for example engineers would be employed in industries which did not come under the Engineering Industries Training Board and likewise builders and commerical staff would be employed by firms coming under the Engineering Industries Training board. It was agreed between boards that they would adopt the training schemes of one of them, e.g. all boards would expect mechanical fitters and turners to be trained according to the recommendations of the Engineering Industries Training Board. Boards were formed over the year—the EITB was one of the first and Retail Industries, one of the more recent and there are some industries for which boards have not yet been formed. The E.I.T.B. and the Motor Industries Training Board are among those which have developed fastest. Each board sets its own levy and grant rate. Some boards have got on further than setting schemes of further education. Taking the EITB, however, it concerned itself at first with setting first year schemes of craft training. A general first year scheme was adopted for all crafts with the intention that in the second and subsequent years training would be given in specialist modules e.g. turners, electrical fitters, welders. The first year scheme was recommended to be in off-the-job training workshops either attached to firms or set up by the board itself or in many cases in technical college workshops. In the latter case the colleges were more easily able to give an integrated course of education and training.

It should be said that the expected rapid expansion of demand for college places did not take place because it seemed that major industries had already established training schemes and the firms which were not providing training regarded the levy of the board as just another tax like selective employment tax which was introduced at about that time, which they were able, to recover by passing on to their customers. None the less, considerable gains have accrued already from implementation of the Act. The Science and Art of Training is being considerably developed, there is a growing force of training officers and instructors employed by industry and the boards and these are required to follow courses in Technical colleges.

There has developed a rapid and fruitful interchange of ideas within the U.K. and with practice abroad and the skills of job analysis, devising curricula and training are developing rapidly, such that training time is bing drastically reduced and the resulting greater efficiency will show overall economic as well as social benefit.

The E.I.T.B. has only recently published its first recommendations on "The Training of Technician Engineers" and work is continuing in the Technician field. A Report on an inquiry into the employment and training of technicians in the engineering industry 1969 is now being considered by the board and may be published shortly. This inquiry was a nationwide survey and the findings occupy some 60 pages. The Report analyses in some detail where technicians work, their age and qualifications and the work they do. It should be noted that 'Supervisory activities accounted for only 6 per cent of the total time worked'.

To answer the question 'what is the relationship between I.T.B.'s and technical colleges', it is worth noting that the Technical Training Policy Committee of the E.I.T.B. has some 14 members of whom the Chairman is Head of Department at a College of Technology and four others are a Principal, an examining body officer, and two are H.M.I. (Technical Education).

Release to colleges for further education is compulsory for the receipt of grant. Many colleges conduct full-time training courses for the board. Training officers and instructors courses are conducted in colleges. The devising of educational curricula to match the board's training requirements is a matter for the educational service and is done by committees with a membership predominantly of teachers. The integration of training and technical education to keep instruction in step means close liaison between college and works training staffs.

ANNEXURE B

Electoronics and Telecommunications

I was asked to make observations with particular reference to the fields of electronics and telecommunications and in the last few weeks I have looked more closely into the departments of colleges offering these subjects and also I have visited small and major industries in Madhya Pradesh, Andhra Pradesh and in Bangalore.

The present industrial firms who manufacture electronic and telecom equipment and components in India have been built up either in collaboration with firms abroad or with the Departments of Defence or Posts and Telegraphs. In one case a government research establishment formed the initial cadre of what is now a public undertaking.

The manpower needs of this type of manufacturing industry are in the phases of:

1. Research and Development.
2. Product development.
3. Production planning including development of production test equipment which in this industry is often electronic.
4. Direct production and testing.
5. Servicing or maintenance.

Research and development activity is minimal because of the collaboration. It is development of the product and of production test equipment which needs engineer specialists in electronics and/or telecommunications. On an all India basis there seems to be a ready supply of graduates capable of developing this activity and industry seems able to be highly selective in recruiting these people. Possibly the major employement in these industries is in production planning and control of production. It should be borne in mind that this is a production engineer (sometimes a chemical or process engineer) activity rather than requiring specialist electronic engineers. None-the-less the production engineers need some knowledge of electronics. Bearing in mind the wider applications of electronics and for that matter other systems such as pneumatics and oileomatics, study of system engineering with understanding of basic theory is becoming a desirable component of all production engineering curricula.

One of the major firms I visited contemplates a five times or more expansion of their activities in the next two or three years but after that expect that their need of new engineers will flatten off. This industry is hoping that the educational system can assist with or take a major part in the training for this expansion. While the time scale is too short for a college or colleges to acquire staff, develop curricula and run a course (and if they did so, the demand would disappear after or before the first output), advantage might be taken of this wish of industry to establish training schemes in co-operation with the colleges so as to build up expertise and capability for future wider needs.

At the present scale of production, the manufacturers seem able to look after the servicing of their equipment by setting up their own agencies in the major regional centres, or they supply equipment to users such as defence, posts and telegraphs who have their own trained servicing personnel. At some later stage when more equipment is produced for the public at large, there will be need to anticipate the need for servicing tchnicians and mechanics.

I should complete this annexure by referring as I did in my joint statement with Mr. Henninger to the need for college courses to be up dated, oriented towards the transistor and other solid-state-devices, for more laboratories to be equipped on a self-made basis with circuit boards. Some departments are making good progress in this direction but there everywhere seems to be need of a low priced oscilloscope so that this valuable teaching aid can be available in quantity almost on the same scale as the universal test meter.

In the field of electronics more than any other, because of the rapid developments in technology, there is need for teachers and practising engineers to be continually updating their knowledge and it is suggested that due provision and allowance should be made for this especially in the colleges which may have only one teacher working in isolation in this field. An appropriate engineering college or Institute of Technology working in collaboration with specialists in industry could usefully run frequent courses on an all India basis.

SECTION III

Suggestions concerning Polytechnic Education in India

Prof. W. D. Kurz, West Germany.

Introduction

As other foreign advisers, I was given the opportunity to visit institutes of technical education, industries, and other bodies to inform myself about the present conditions of technicians' education. During six weeks of travel I was in Delhi, Calcutta, Bombay, Coimbatore, Bangalore, Madras and Hyderabad where I saw various kinds of institutions and industries and talked with representatives of Government, principals, staff members, students, former students, industrialists, and others who are concerned in the education of technicians. To all of them I wish to express my thanks for their friendly help, and especially to Prof. G.R. Damodaran for his careful guidance.

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1. Education of Technicians Germany—India

1.1. Job-Description, Routes of Education

I take for granted that the reader is familiar with what in India is understood by the word technician. In Western Europe and in the United States the jobs of technicians do not include—in contrast to India—the duties of supervisors and foremen. The German routes of education leading to technicians, in the Indian sense of the word, are shown in Chart I. It must be mentioned that in spite of the schematical similarity between the Indian route of education and the three left column of the German routes leading to "Ingenieur (graduiert)" the jobs obtained are mostly different. Only a small share of those who become

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*Submitted in December 1970.

“Ingenieur (graduiert)” get jobs as technicians. Most of them share the field of professional work with “Diploma-Ingenieuren” the German species of professional engineers.

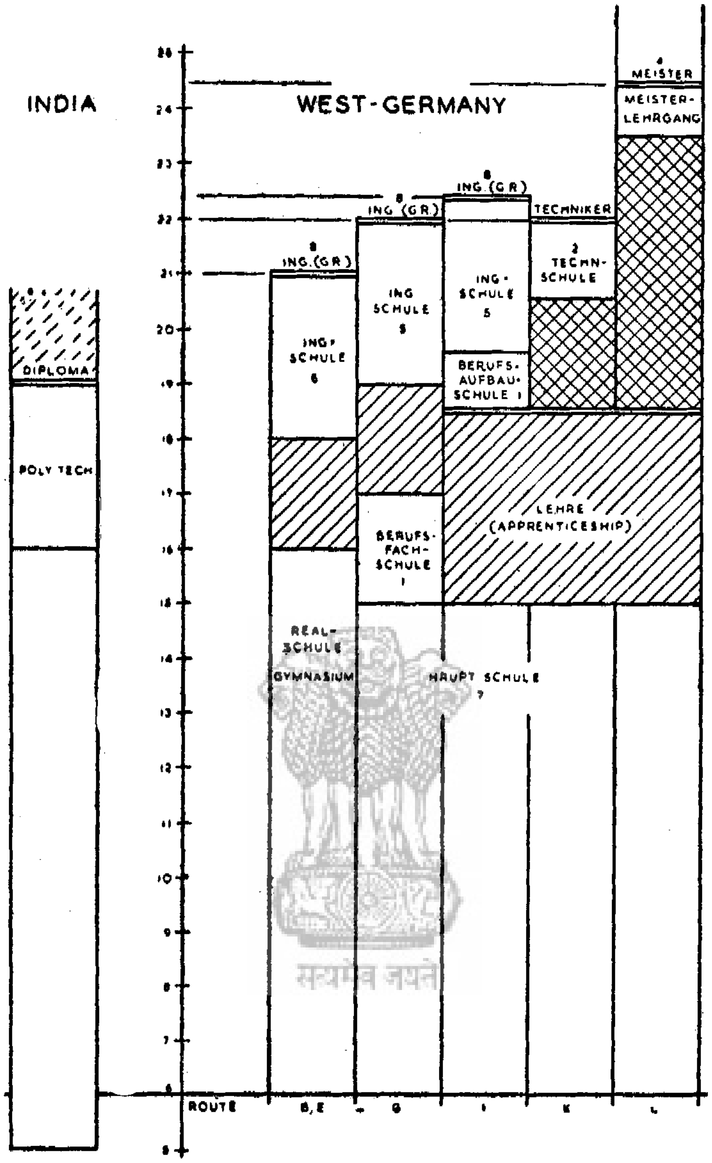

CHART 1

1.2. Comparison

Levels: In Germany, there are three kinds of technicians (again on the basis of the Indian term):

“Meister” (supervisors) have the greatest practical (8.5 years) and the lowest theoretical (1 year) background.

“Techniker” have less practical (5.5 years) but more theoretical (1.5. years) background.

“Ing. (grad.)” have the highest theoretical (3 years) and the lowest practical (2—3.5 years) background.

Degree of diversification: There might be about 60 different branches *at each level* in Germany. In India, the total might be 30. Thus the ratio of diversification is about 180 : 30.

Placement of industrial practice: Industrial practice as a part of technician training occurs before theoretical schooling in all cases in Germany, and in India, in-between (sandwich) or after, or, due to present difficulties, not at all.

2. Critique of Indian System

There is little to be added to what one can readily gather at present about the shortcomings deficiencies, and drawback of the present system. Therefore a brief description of the main aspects might do. Although the German system is far from being ideal it avoids to a great extent the weaknesses of the Indian system. Therefore a comparison of the German and Indian systems is used here for demonstration. The comparison suggests that students in India have less motivation because they do not know beforehand where the road that they are taking will lead. They have *less understanding*, especially in practical subjects, because they only vaguely conceive what their teacher is talking about. They are too young (19) at the beginning of their professional career when they are expected to be supervisors and they have too little practical skill. These latter factors render them unsuitable to supervise skilled workers who are superior to them both in age and in skill. The teachers have very little or no practical experience. They have to teach according to a prscribed syllabus whether this syllabus makes sense or not in any particular situation. They have to prepare their student for external examinations and consequently the most successful teacher is the one who has the greatest experience with examination questions. They cannot collaborate with industry because industry hardly accepts them as partners. The inefficiency of teaching described above is partly due to the present administratively structure of polytechnics.

3. Suggestions.

3.1. Structure of Polytechnics.

The structure suggested is in a large measure evident from the page "Contents" itself, the following paragraphs being the respective interpretations.

3.1.1. Rules Common for All Polytechnics.

3.1.1.1. Duration of Courses including Industrial Practice.

The total duration of courses should be 4 years including one year of industrial practice. The placement of the latter should be adapted to local conditions (see 3.1.2.2.).

3.1.1.2. Previous Education of Students (App.)

The previous education of students should last 12 years as far as minimum conditions are concerned (see 3.1.3.1.). At a later date the conditions for admission should include one year of industrial apprenticeship but only after the placement as suggested under 3.1.1.1. has come into vogue.

3.1.1.3. Procedure of Examinations.

There should be only internal examinations. Externally imposed Rules and Regulations should be confined to procedure (pass criteria, timing, duration, observers admitted etc.). The questions, practical problems, projects etc. forming the examination should depend on the syllabus actually taught (see 3.1.3.2.). The marks awarded should be composed of results of continuous evaluation and the final examination.

3.1.1.4. Previous Education and Industrial Experience of Teachers (App.)

Minimum: Bachelors degree plus three years of industrial experience of Diploma plus six years of industrial experience (see 3.1.2.3.).

3.1.1.5. Procedure for Engaging Staff Members (App.).

Every Institute should be entitled to select and employ a certain number of staff-members (teachers, administrative officials, librarian, physical director etc.). Applicants for first employment as teachers should be required to pass an oral-*cum*-lecture and colloquim test given by the teaching staff of the institute After engagement all teachers should be required to attend a course of pedagogical preparation at the TTTI (see 3.6). Also in the case of promotions and appointments to higher posts the staff should have the right to nominate the candidate.

3.1.1.6. Teaching Obligations, Size of Classes (App.)

The number of class hours a teacher has to take per week should be low enough to allow for due preparation of instruction (about 20 units of 45—50 minutes each). The size of classes should be limited so that careful evaluation is possible (about 35 students per class).

3.1.1.7. Salaries

Teachers' salaries should be high enough to attract experts from industry to teaching jobs (see 3.1.1.4).

3.1.1.8. Qualifying Period, Rules of Transfer.

Among other things the attraction of the teaching profession lies in security and independence. Therefore the period of probation should be limited to one year and transfers should be admissible only under certain conditions.

3.1.2. Actions to be initiated by Institutes, approval of Ministry necessary

3.1.2.1. Curricula, Establishment and Abolition of Courses (App.)

Changes of curricula should be allowed whenever there are sufficient and important reasons to change them. Moreover there are some courses for which the present demand is minimal (Civil Engineering in some places) while in some other courses the present uniformity in syllabus (by way of level or content or both) is not suitable for all places (too ambitious in rural areas, too little specialized in industrial areas). Recently some selected polytechnics have been given some autonomy to develop their curricula themselves. This is all right as far as these polytechnics are concerned, but they should not be made models for other polytechnics because institutes which are less favoured and less affluent and those situated in smaller cities, with less industry around, cannot copy these models. These should develop their own curricula suitable to their own conditions. In most cases, a modification of syllabi will do (see 3.1.3.2). Establishment of new courses and mainte-3.1.3.2.). Establishment of new courses on the fulfilment of several criteria *viz*. Intake expected in the long run.

Jobs available in the long run.

Attitude and potential of industry to employ apprentices etc.

I have seen some excellent examples of curriculum planning in cooperation with industry on the basis of local conditions. Greater variety is not necessarily synonymous with greater specialisation which may lead to unemployment. Above all, it should mean variety in subject groupings and levels. Hence external examinations will be nearly impossible (see 3.1.3.3.). I believe, however, that the lack of administrative control implied in the abolition of external examinations will be compensated by the control which will be exercised by the success or failure of the institutions themselves. This will work to some degree by itself as soon as institutes suffering from small admission figures and unemployment of their turnouts are allowed to shrink and prospering ones allowed to grow. As far as the existing practice is concerned there is little use in controlling a so-called level as long as this level is not determined by industrial needs.

Regarding the present courses in Civil Engineering I learned that nearly all diploma holders apply for employment by government, whilst private industries have little need for civil engineering technicians. I believe that they would have demand if it is stipulated that the drawings presented for approval must fulfil the standards of technical drawings and that the erection of buildings must be supervised continuously by the private firms themselves. Of course, also in Civil Engineering a technician must have had industrial practice, which means that he must have worked on the building site himself.

3.1.2.2. Placement of Industrial Practice.

Indust practice can be placed before, in-between, and after theoretical studies.

Placement before has the following advantages:

A part of the in-plant training can be the same as given to those who are going to become skilled workers. It can replace training in manual skills at school. No close relation is necessary in this case between practice and theoretical schooling.

It can be combined with the pre-entry industrial practice suggested under 3.1.1.2.

Motivation and understanding during period of the theoretical studies will become better as a consequence.

Placement in-between (sandwich) might be ideal where collaboration between industry and polytechnic is so close that industrial practice can be adapted to the actual level of theoretical schooling. Where this is not possible we have a pseudo-sandwich before us which, I feel, is not worth the effort.

Placement after allows a higher degree of specialisation than can be offered by the polytechnic. Vocational adjustment, however, is a duty which industry has to take over. Also here the programme of training must be harmonized with the foregoing theoretical course, and it should include project work.

The question which of these systems can be implemented effectively depends on local conditions and since all of them have advantages and disadvantages the choice should be left to the institutes instead of all institutes following a uniform arrangement. Migration of students between institutes will be complicated when varieties of this kind are permitted, but as long as the migration rate is as today (about 1 per cent as I have heard) this should not be considered a problem.

3.1.2.3. Engagement of Staff-Members (App.)

The procedure has been described under 3.1.1.5. In comparison to the present practice a vacant post can be filled quicker under the proposed procedure and a new staff-member is more likely to have the appreciation of his colleagues. Moreover there will be a better chance to get experts suitable for the posts.

3.1.2.4. Purchase of Equipment.

If there are different courses and different syllabi (see 3.1.2.1. and 3.1.3.2.) the equipment can no longer be uniform. Henceforth it should be up to the heads of laboratories and their principal to determine their requirements and to apply for purchasing the necessary equipment.

3.1.3. To be settled by Institutes Autonomously.

3.1.3.1. Admission Criteria.

Today, if there are more applicants than places the choice is normally made automatically by the number of marks the students have obtained earlier. The quality of foregoing schooling might, however, be different though the marks may be similar. Therefore the institutes should be allowed to determine their own criteria for admission which, of course, must not interfere with the minimum standard prescribed (see 3.1.1.2). Preference should henceforth be given to applicants who have had earlier industrial practice. This could be a means of transition to the final status recommended under 3.1.1.2.

3.1.3.2. Syllabi (App.) (see also 3.1.2.1).

The present syllabi, compulsory for all polytechnics, are unable to bring about equal levels at different institutes, even if this is desired. They cannot meet special demands on the one hand and on the other are likely to be overloaded and outdated. (The author of a syllabus to be used by different institutes cannot take the risk that something is missing). The teacher is forced by means of external examinations to follow these syllabi and, even if he had time to spare, he cannot introduce a new chapter because students would consider that a luxury. There is no objection if the syllabi are worked out by special bodies (as has been done in the past) as part of curriculum planning. They should, however serve only as guides. A teacher should be allowed to modify these syllabi whenever he thinks it useful for the purpose of modernisation or job adaptation. This is not possible until the examination system is changed.

3.1.3.3. Examinations.

All examinations should be internal. By this means the teacher is to a certain degree independent and only then can he teach his students how to work independently. There is less danger that examination questions are repeated because the questions can be related immediately to what has been taught or discussed before which is likely to be a little different each year. Moreover there will be a wider range of examination methods. It will be possible now to do real design work and not merely drawing (design can never be evaluated in external examinations). A teacher who is independent and responsible for his own teaching, is likely to be highly respected by his students and will contribute a great deal to their motivation. It will not however be possible to get such teachers except under certain conditions. Some suggestions in this regard are given under 3.1.2.3. and 3.2. Incidentally however, there will never be teachers like that until they are given opportunities to be so. I often heard that the teachers would not have the necessary integrity; but at present because of the limitations imposed by their own inadequate professional experience, uniform syllabi and external examination system they are neither called upon nor in a position to display any integrity.

3.1.3.4. Organisation of Labouratories and Utilisation of Equipment (App.).

Analogously to the framing of syllabi, the organisation of laboratories and the method of evaluation of laboratory work should be left to the head of a laboratory. Moreover there should be no restrictions regarding the use of equipment for industrial purposes (test, research, and fabrication of specials set-ups) as long as this does not interfere with teaching (see 3.3).

3.2. Faculty Development (App.)

This para refers mainly to the present teaching staff. This is so because the percentage share of new teachers engaged under conditions described under 3.1.1.4. and 3.1.2.3. will not rise immediately but very slowly. There are recommendations how to get rid of "bad teachers" by inquisitory measures. But struggle for survival is, as I think, not a good basis for faculty improvement. My suggestions are: Engagement of new teachers under conditions as mentioned above including much higher salaries. The present teachers can obtain salaries of equal size after fulfilling certain conditions such as undergoing industrial practice during summer vacations, participation in pedagogical courses, Summer School Courses, Degree Courses, obtaining credits in curriculum development etc. All this should be the subject of a special scheme to define what is suitable for teaching different subjects and how far each is counted for salary increase. By this means the rest of the teachers, who do not make use of the opportunities, will be drained off automatically.

3.3. Collaboration with Industry.

Every polytechnic should establish an advisory council composed of the principal, members of the teaching staff and representatives of industry in order to discuss and to settle all questions of mutual interest, *viz.*, placement of industrial practice in the curriculum, contents of industrial practice, and places for apprentices; (Since it is unlikely that industry will offer enough places, an amendment to the Apprentice Act might be necessary as proposed by Shri L. S. Chandrakant in "Polytechnic Education in India").

Curriculum development and adaptation of present curricula to industrial needs (participation of former students); Lectures and courses held by experts from industry or teachers of institute;

Industrial problems of research, development, and testing to be solved by teachers. (This is possible after they have had industrial experience);

Places for industrial practice during vacations for students and lecturers;

Visits to industrial firms;

Supply of printed matter (catalogue etc.) for students and teachers;

Grants of money and equipment. (machine tools, testing equipment, computers etc.);

Scholarships for students and teachers.

This list may appear rather optimistic compared with the present reality, but collaboration will improve as soon as there are more teachers who have been experts in industry earlier.

3.4. Motivation

It might be useful if in the last years of preparatory schools the boys and girls get some instructions about India's tasks and problems of social and industrial development. Other sources of motivation are industrial work or training before theoretical studies and, last but not least, teachers who have a motivation themselves. However, the main source of motivation is the reputation a diploma holder enjoys and the salary he gets. The motivation of teachers has partly to do with the way they become teachers (see 3.1.1.4). As long as the period of industrial experience of three to six years is not merely an apprenticeship but a period of successful career, applicants for teaching positions will normally have an inclination for teaching.

3.5. Institutes in Rural Areas

There are many polytechnics in which the admissions went down to very low figures. For instance in Mysore State one third of the institutes have less than 30 per cent admissions compared to capacity On the other hand there are many institutes having admission figures between 90 per cent and 100 per cent of capacity. The first group belongs to rural areas; the second to urban areas.

That means that the low admission trends are not only brought about by the present economical situation. The main reason is the location of these institutes in areas where they have little basis to exist and there should be no compunction about closing down some of them. The majority of the rest should be required to thoroughly modify and reorient their courses in keeping with local needs. (The staff-members have plenty of time for curriculum research at present when admissions are so low). At any rate there will be a great capacity to spare both in facilities and in staff. Partly this could be used to establish new courses in the field of agriculture. The levels and contents of these courses will have to be very different in different locations. There are areas where the degree of mechanisation is so low that a start can only be made by some Peace Corps approach in order to create a demand of skilled labour and machinery in the future. In some areas there is a certain demand for distribution commissioning and maintenance of small size machinery like power tillers and pump sets and there are also other areas where there is a demand for distribution and maintenance of heavy equipment such as tractors and accessories.

A curriculum cannot always be planned after existing manpower demands (in area where there is no technical manpower demand). In such cases it will be necessary to establish at first a programme for agricultural development and mechanisation. It should be up to the local authorities of the Ministry of Agriculture to develop curricula according to local needs. In most cases the diploma level will be too high and instead the ITI level might be more suitable. Analogously, courses for Fishery could be established. A programme of this kind might help to prevent a part of the rural intelligentsia from emigrating to the big cities.

3.6. Role of TTTI's (App.)

The present programme of TTTI's is surely useful (upgrading courses, teaching pedagogy, development of educational aids) but it might be many decades until all teachers have attended these courses. The TTTI's should withdraw from upgrading courses and leave this field to the IIT's and industry. Instead they should concentrate upon the latter items. In addition pedagogy should include instruction about how to plan, conduct and evaluate examinations (see 3.1.3.3). New teachers should attend a rather short course (about a quarter of a year) to get familiar with basic ideas (see 3.1.1.5). Those who are already teaching may choose between attendance at the same course of participation in an equivalent correspondence course (see 3.2). By no means should performance at this course play a dominant role in the appointment of new teachers. A teacher who is competent in his technical or scientific fields, that is someone who knows *what* to teach, is normally able to find a way *how to teach*. And generally he will be more successful by teaching in his own style than by adopting some so-called scientific method. Within the frame of autonomy as described earlier a centre for clearing and exchange of curricula and syllabi will be necessary. Perhaps the TTI's can take over this task.

3.7. Short-Term Long-Term Measures

The reorganisation could be started after a short period of preparation if responsibilities and powers are delegated successively to a lower level as described above. "Successively" refers to both sequence of measures and sequence of institutes. The introduction of industrial apprenticeship after the issuance of an amendment to the Apprentice Act is likely to take the longest period of time and should mark the end of the transition period. Institutes which, after a due period after the issuance of the act, do not succeed in getting the necessary training places for their students, may not have the necessary basis for existence. There are, of course, some aspects such as faculty development and collaboration with industry to the full extent where no limitation can be set on the transition period.

The success of a reorganisation, as outlined above, will depend not only on the enunciation of policy, delegation of powers and autonomy, and enactment of legislation but also on understanding, acceptance, interpretation, and implementation of the spirit behind the proposals. The principals hold the key positions and success can only be achieved if they are convinced by and are enthusiastic about the plan for reorganisation, and are ready to ensure that the delegated authority and autonomy are exercised.

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APPENDIX 3.1.1.2

Previous Education of Students

The following reasons favour the extension of the preceding school course to 12 years:

1. Complaints by almost all people concerned with technical education about the shortcomings of the present school education.
2. Too low an age presently at the start of the professional career (19 years now).
3. A comparison with technician education in other countries.

A comparison with the technician training in the U.S.A. and the countries of Western Europe* shows a school education period between 9 to 13 years in those countries against the 11 years prevalent in India at the moment which would seem to be a good median value. However, if one considers the special situation of present day India, this 11 years period does not appear to be sufficient. In order to illustrate this point a comparison should be made between "Techniker" and "Ing. (grad.)" (See 1.1.) on the one hand and the Indian Technician on the other. Indeed, the previous schooling of the "Techniker" is 9 years (it is proposed to raise this to 10 years), but it should be remembered that most of the people who attend the "Techniker" course are already specialists in the same field in which they are seeking education. This is not valid for the Technicians in India, since, for various reasons, education here cannot be so specialised. In addition there is hardly any problem of communication in Germany Even if the ability of "Techniker" to express themselves in their mother tongue is not high, it is acceptable through the narrowness of their fields of specialisation.

In India the lesser degree of specialisation brings, with it the need for a larger technical vocabulary for the technician. This apart, there is the further demand that he should have a good command of at-least two languages: English, in order to understand his superiors and to be able to read technical literature and Regional languages (Hindi, Tamil etc.) in order to make himself understandable to his subordinates. It can happen very often that the technician's mother tongue is not one of the main Indian languages, and as a result both the languages mentioned above become "foreign languages" for him. One should further take into account that the number of school years are to be valued by different standards, depending upon whether schooling starts at the age of 5, 6 or 7. Schooling at the age of 5 serves more to get the child acclimatised to the school rather than to acquire knowledge. In all the countries of Western Europe and in the U.S.A. schooling begins with the age of 6 or 7 years.

The only exception is the U.K. where it is 5 years. While making this comparison one should moreover keep in mind that in the above mentioned countries a major proportion of the children grow up in technically more developed surroundings, which contribute towards acclimatisation to industry and towards better grasp of technical contents at the school.

On the above considerations and on the basis of 9 years of schooling for the German "Techniker" (which even there is a poor minimum) the requirements of previous schooling in the case of Indian students could be worked out as below:

Previous schooling as in the case of German "Techniker"	9 years.
Add for:	
(*i*) The earlier start of schooling	0·5 years
(*ii*) One or two "Foreign languages"	1·5 years
(*iii*) Influence of environments	0·5 years
(*iv*) Degree of specialisation	0·5 years
TOTAL	12 years

For " Ing.(grad.)" the considerations are similar:

Previous schooling	10 years.
Add for:	
The earlier start of schooling	0·5 years
One or two "foreign languages"	1·5 years
Influence of environments	0·5 years.
TOTAL	12·5 years

It should be understood that such a "calculation" is only a frame-work for thinking. Since, however, the allowances made above tend to the lower limit, the result of 12 years of schooling arrived at is likely to represent more a minimum rather than the ideal. To allow for a still longer period does not seem realistic at present.

The age of the "Technician" would amount to $5+12+4=21$ years if the suggestions made in this report are accepted.

Adding one more year for industrial practice prior to entry into the Polytechnics (See 3.1.1.2) the age amounts to $5+12+1+4=22$ years.

APPENDIX 3.1.1.4

Previous Education and Industrial Experience of Teachers

The qualifications necessary for the teaching staff should not be centrally and generally fixed except for the specification of the necessary minimum requirements. The necessary qualifications should be related to the main subject which the teacher is expected to teach.

In the basic science subjects (Physics, Chemistry, Mathematics etc.) a necessary condition is the scientific ability of the teacher. These subjects are not industrial application oriented, but prepare the student for subjects which are oriented towards such application. However, it is to be expected of the teachers of these basic science subjects that they have an idea of what is finally expected of the technician when he goes out of the Institution. It would be certainly easier for the teacher to have this background, if he himself has had experience of practical nature. This will enable him to know, at least in his field, how great the gap between the scientific activity within the walls of the

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* See "Description of Systems of Engineering Education in EUSEC and OECD Countries", Paris 1964.

University and the demands in actual practice outside is. One should not exempt even a Masters Degree holder from the requirements regarding Industrial/Practical experience (Suggestion: minimum three years).

In those subjects which have a direct bearing on the later professional activity (like Material Technology, Strength of Materials, Design, Material Handling, Production Technology, Industrial and Labour Management etc.) the emphasis should be on the knowledge of practice. Depending upon the nature and demands of the individual subjects one might admit in certain cases people with lesser educational qualification if it is adequately compensated by greater practical experience (Suggestion. A Diploma holder with a minimum of six years industrial experience).

One should, however, keep in mind that the above minimum requirements cannot alone guarantee the quality of teachers. It is definitely not desirable that persons who want to try their luck in the field of teaching after a few unsuccessful years in Industry should be engaged as teachers. Only if a person applying for a teaching job is working in Industry with success will there be a good probability that this person has an inclination for teaching and is not merely trying to get an advantageous job. Mostly this inclination to teach is matched with ability. However, the applicants belonging to this category will be prompted to do so only when they are offered a proper remuneration.

APPENDIX 3.1.1.5
Procedure in Engaging Staff Members
APPENDIX 3.1.2.3
Engagement of Staff Members

The selection for the appointment of a teacher should be made by the teaching staff of an institution. I would like to recommend in this context a procedure which has proved its worth in many Ingenieurschulen in Germany (See 1.1). The applicant delivers a lecture relating to his field of study, the title and contents of which are left for him to decide. The level of the talk should be so chosen that it corresponds to the level of his audience, namely the teachers. A discussion follows on matter relating to the subject and the person under discussion. The ensuing voting is done separately under the view points of subjects, pedagogical aptitude and personality aspects. The relative standing of the various applicants is listed by comparing the results of these votings. If a candidate is accepted, he should undergo a preparatory course in a TTTI, which should be more of informatory nature (specially considered in 3.6).

It should be borne in mind that the fear that one could fail in a test conducted purely on pedagogical standards, could prevent specially qualified experts from applying for these posts.

APPENDIX 3.1.1.6
Teaching Obligation, Size of Classes

Both the figures for teaching load (recommended: 20 periods per week each of 45 to 50 minutes duration) and for the maximum class strength (35 students) are average values based on the experience in Germany.

It is not possible to avoid the difficulty that this prescribed teaching load is too small for the take-it-easy-teacher and too big for the industrious and conscientious teachers. In addition it lies in the nature of the different subjects taught, that the demands made of a teacher in respect of preparation for the class and the evaluation of the students' effort are different. One could compensate for the latter by adding a certain number of periods for preparation and evaluation to the actual number of class hours.

The suggestion on the maximum strength of a class is not valid or all the subjects. In design and Laboratory classes the students should be divided into groups. The size of the group is governed, in the case of design classes, by the time which the teacher has to devote to the individual students in the group and, in the case of Laboratory classes, by the number and type of the practical exercises being conducted.

The above-mentioned suggestions are based on the assumption that the same teacher is responsible both for the lecture and tutorial part of particular subject. Under such circumstanes the time tables need not always specify whether a particular period in such a subject is devoted for lecture or for tutorial, since the teacher adjusts the programme according to the requirements of the stage of teaching that particular subject.

The Lecturer-Tutor system enables big institutions to have somewhat less teaching staff in so far as the number of students attending a lecture class is limited only by the capacity of the hall in which the lecture takes place. (In Germany, this system is followed almost exclusively in Universities). On the other hand, the batches could be made sufficiently small to permit individual attention of the tutor to the students in the group. However this presumes that there is good understanding and co-operation between the lecturer and the tutor. The latter must not only be able to explain and to give exercises on the lecture content but must also be willing to do so. A further characteristic of the system is the rank difference between the lecturer and the tutor, with the advantage of promotion possibilities for the tutors. However this can also be interpreted as a disadvantage in so far as internal rivalries and intrigues for promotion may spoil the working atmosphere. A further disadvantage of the Lecture-Tutor system wherein common Lectures are given to combined classes (comprising students who will later branch out into specialisations) is that the lectures should include all the aspects of the basic subjects relevant to all the later specialisations. Thus, basic subject material which may be unnecessary for particular later specialisations cannot be dropped out.

If, however, one decides to limit the class strength as per the recommendations suggested, it might be possible to entrust one single teacher with the whole Mathematics syllabus for example say, civil engineering (If, due to this, the load on a teacher becomes unduly large a distribution can be achieved by assigning another teacher to handle the subject for the next year in rotation). This enables syllabus matching without considering the other curricula. The smaller group in the class also enables to a certain extent the clearing of doubts that arise during the course of the lesson and the immediate adoption of a teaching rate suitable to the existing comprehension ability of the students.

APPENDIX 3.1.2.1

Curricula, Establishment and Abolition of Courses

There should be provision to enable changes in existing curricula, introduction of new courses and abolition of existing ones if there is an actual need justified by further circumstances (See 3.1.2.1). In addition to this provision institutions should examine their curricula at periodic intervals. The frequency of this review should be once in two years, and the timing for different polytechnics could be so spread over the two year period that the concerned authority should have no difficulty to take a quick decision on the suggestions resulting from these periodic reviews.

The following procedure is recommended for the periodic review:

The syllabi of the various subjects, with or without alterations, should be submitted by the teachers to the Heads of Departments who in turn hand them over to the principal. At this stage it is possible to bring about a correlation of the syllabi by mutual consultations of the concerned teachers and departments if this has not already been done. It is quite possible that such correlation of the syllabi can result in a change of curricula. After this the principal, in his capacity as the Chairman, calls together the members of the advisory council and enunciates the reasons for the continuance of the old curricula or for the suggested changes as the case may be. At the end of the following discussions, a unanimous suggestion should normally emerge and be sanctioned by the whole body of the advisory council. In the absence of unanimity, the various view points should be recorded in the minutes of the meeting. These suggestions of the advisory council, together with the minutes of the meeting, are submitted to the duly constituted authorities. A sanction should be needed only for curriculum change and not for syllabus changes.

A main objection against local or institutional framing of curricula might be the fear that there is no longer a control to maintain a certain level of polytechnic education. I would agree that a certain level should be secured in the future too but this level *need not be an equal level.* If, for example, the textile and foundry industries in Coimbatore are of a high level from the point of view of the techniques used and, if in Bangalore these industries are only of medium level, then the contents of courses in Coimbatore and Bangalore could be different. For the same reasons the courses in Production Technology or Welding could have different course contents in Madras and Trichy on the one hand (as the corresponding industry is of high level) and in Coimbatore on the other hand (where the corresponding industry is only of medium level). It would be useless and inadequate to local industrial needs to teach the latest techniques in a location where, in all probability, the students will never see them either as apprentices or, later on, as technicians. The contents that in locations of lesser development, technicians should introduce new techniques cannot be accepted except where industry has a very low standard. In practice this task is generally taken over by experts who are best acquainted with these techniques and not by greenhorns who have just heard something about them. Moreover, there are educational routes of higher levels for this purpose.

Regarding maintenance and holding up of a certain level of education I would rely upon the influencee of industry (the means of influence are described above and under 3.2.). Moreover, there is a general tendency for institutes to improve as long as they have to justify their existence themselves (in India there have been instances of this in the phase before syllabi were unified and institutions were taken over by the government). After all there is the safeguard that a curriculum of too low a level might not be approved of after submission.

It is to be understood that level in this context means level of course contents. The level of teaching, which is something different, can be low or high independently and should always be as high as possible. This, however, is a matter of proper selection of staff members (see 3.1.2.3.) and faculty development (see 3.2).

APPENDIX 3.1.3.2

Syllabi

Means for checking up syllabi and curricula are suggested under App. 3.1.2.1 and App 3.2. In both cases the suggestions are mainly related to the applied subjects. Then the question arises to what extent the syllabi of the basic science subjects should be tailored to the needs of the applied subjects. The starting point and core of every syllabus should be the consideration: *what must be the student's ability at the completion of the course.* Just as the standards existing in the industry govern the course content for the subjects in the final period, the basic subjects must also be conditioned mostly by the succeeding practice oriented courses. Reviewed under such considerations, today's syllabi would undergo perhaps major modifications. In such a case the teachers would not be in a position to teach effectively without acquiring some additional knowledge, if necessary through special courses (e.g. Physics and Chemistry staff in the field of corrosion protection, Mathematics teachers in the area of Statistical Quality Control). Also here the Principal should be entitled to enforce, if necessary, such attendance in special courses.

APPENDIX 3.1.3.4

Organisation of Laboratories, Utilisation of Equipment

It has already been stated that it should be left to the head of the Laboratory to equip and organise the laboratory as he thinks best and to set-up the criteria by which to evaluate the exercises of the students. It might be pointed out in this context, that, in Germany, oral examinations aiming towards checking the general comprehension have proved themselves, since the laboratory record offers usually no other evaluation criterium than the beauty of the handwriting. When setting-up and supplementing a laboratory the choice of the equipment should be exclusively governed by the objectives and methods of the teaching. In releasing money for this purpose there is the likelihood of the hurried acquisition of costly prestige pieces, which may later on prove almost useless. To avoid this risk the money could be placed at the disposal of the institution for utilization over a period of several years. The heads of departments and laboratories should be given opportunities to obtain exhaustive information prior to acquisition of major equipment (trips to other institutions where competent experience is already available in this direction, comparison of different quotations, correspondence with similar institutions in other countries etc). The requirement that all institutions should possess a uniform pattern of equipment is ruled out as soon as it is accepted that the institutions should match their course contents to the existing needs and that they should be continuously modernised in keeping with technical development.

APPENDIX 3.2

Faculty Development

While the pedagogic skill of a teacher improves with more teaching experience, his industrial experience tends to become out-dated and forgotten in case he only teaches. To counteract this phenomenon there are two possibilities:

The "Natural" Contact

In case the teacher under question is a person of respectable standing in his field, there is often the possibility that he could continue his industrial contacts in a consultative fashion and for solving problems of a limited nature. This is the best method to remain in touch with the field. The additional income resulting from this kind of activity might be an additional motivation for the teacher. This type of exchange should be permitted without any restrictions as long as the primary duties as a teacher are not neglected.

Industrial Training and Courses for the Purpose of Further Developments

It is not always possible for the subject of teaching and the former industrial activity to cover each other completely. Moreover a further "natural" contact might not be feasible by the very nature of the structure of the industrial organisation (mass production and high degree of specialisation in a big). In such cases the teacher should be given an opportunity to work in the industry, in fields where he has the feeling that he does not possess the requisite practical background for teaching. The industry should come forward here and offer vacation openings for teachers, which could be brought out in a catalogue form accessible to all teachers. However, one should not mistake industrial training with "sight seeing". The teachers must work on responsible tasks in the various fields like Production, Research or Design or they should follow a task of working out a Programme to supplement their syllabus, or the collection of data for assimilation and analysis later etc. The Institution of Engineers, India can take over the co-ordination of work involved in such matters like getting in touch with various industries, circulating the collected list of vacation openings to the various educational institutions etc. In spite of much support it should remain a primary duty of a teacher to arrange his industrial contacts himself. Of course the teacher must be compensated for the expenses incurred in this Industrial training and should be given an adequate remuneration for the work done during this period. The above considerations are also valid for refresher and upgrading courses for faculty members. The subjects, contents and the organisation of such courses can be similarly taken up by the Institution of Engineers, the National Productivity Council, or similar organizations, as far as practically-oriented fields are concerned Information on similar courses run by the "Verein Deutscher Ingenieure" is available for reference.

Obligation to Participate in Refresher Courses and to gain Industrial Experience.

Since industry alone has a direct interest in the type of education the technicians receive, it should have a far-reaching influence on the quantity and quality of the technicians' education in polytechnics. A committee consisting of representatives of Local Industry and of the Institution of Engineers, India, should have the authority to inspect the curricula and to interview single teachers for inspection of syllabi. (This Committee is not to be mistaken with the advisory council mentioned in 3.3 and 3.1.2.1). In the latter case this Committee may recommend to any teacher to attend a course or to undergo training in industry in case this is a necessary condition for proper teaching. In the event of the teacher not following this recommendation even though he has the opportunity to do so, the Committee can refer this matter to the Principal. The Principal should have powers to enforce the implementation of such recommendations.

APPENDIX 3.6.

Role of TTTI'S

While it is difficult to imagine that in the TTTI's there is a Brains Trust, which possesses the necessary specialist knowledge in all the fields of Engineering, it is almost impossible to believe that the TTTI's can formulate the curricula for the various institutions, which are organised to cater to the local needs. Efforts taken in this direction are likely to lead again to uniform curricula, which among other things is one of the causes of the present crisis in polytechnic education.

It should again be emphasised that an adaptation to the local needs can come only from below and mainly by changes in detail and not through the creation of new curricula from above, however progressive they may be. Even the new courses being at present developed may be suitable for specific institutions but less suitable for other places. Because of these reasons it is recommended that the role of TTTI's be limited more or less to one of providing pedagogical assistance to the Polytechnics.

In the Courses given at the TTTI's (see 3.1.1.5.) and (3.1.2.3) both the newly appointed teachers and those already in the teaching practice should sit together, since this contributes to the practice-orientation of the lessons. The subjects taught should be split into three different groups, viz. educational psychology, educational technology and methods of teaching and grading examination and evaluation. In all the above three groups it should be relatively easy to develop general guide-lines and recommendations for the basic subjects. In the subjects oriented towards practice, it is to be left mainly to the teachers concerned to develop the practical methods because of the variety of the different subjects and of the laboratory equipments. The TTTI staff should consist of a majority of teachers who possess a long experience in teaching in polytechnics and a few graduates in pedagogy. Only then can job-orientation be achieved, *i.e.* direct preparation of the course participants for their future profession. The significance of the "Guidelines for Examinations" lies in the fact that until now there has been no practice of internal examinations in the Polytechnics, whereas the success of the suggested reorganisation would mainly be dependent on the successful introduction of the system of internal examinations. Hence I would in all humility like to enunciate a few basic principles, which have been framed out of my experience:

1. The teacher must clearly tell the students beforehand what the field to be covered by the test is going to be.
2. The level of difficulty of the questions must correspond to the exhaustiveness and level of the preceding lessons.
3. The questions must be so framed as to be unequivocal and clear.
4. In the case of written examinations, the criteria to be adopted for evaluation should be made clear to the students, if possible even during the examination. In the event of the teacher wanting to leave some room for his discretion, he should inform the students about it and give them the reasons.
5. In case there are students who come to ask for an increase (seldom do they come for a reduction) in the marks awarded to them, and if it turns out that the teacher has committed an error in arriving at the marks, he should make the necessary corrections. Of course there are always students who feel that they have been undervalued even when the evaluation has been correct. The teacher should take time off to explain to such students the rules of the game once more.

In spite of all these efforts there would always be examination papers which prove either very difficult or even impossible to evaluate (by virtue of questions which are too difficult, too easy, or misunderstood). In such cases the teacher should concede the failure of the examination to achieve its objectives and repeat the examination instead of trying to make out a normal result by arbitrary decisions. Only through better formulation of question papers, and, if necessary, through oral explanations during the examinations, will it be possible in future to prevent misunderstanding of the assignments. It is advisable to have assignments and tests to consist of an easy part, a fairly difficult part, and a difficult part. This not only leads to a good dispersion in the results but also reduces the danger that the whole examination becomes either too difficult or too easy and therefore disheartening or ridiculous.

The above considerations are valid mainly for written examinations which have the advantage that the results are generally accepted more willingly by students, since they can study their own performance in black and white. Oral examinations demand from the teacher more authority and experience and should be conducted only in the presence of observers (other teachers, sometimes perhaps, students).

The duration of a written examination should at least be 90 minutes. In Germany, this duration equals the duration of a lesson period. In India, however, it would be possible to have examinations of this duration only with special arrangements (exchange of periods). The possibility of having examinations at any time can be secured by arranging two successive periods of the same subject in the time-table so that it is left to the teacher to use them for examinations or for classes.

SECTION IV

An Advice on Reorganisation of Technical Education in India[*]

Dr. Ing. Minoru Shimosaka (Professor Emeritus, Tokyo Metropolitan University).

1. *Introduction*

In consideration of the necessity of development of polytechnic education in India, the Ministry of Education and Youth Services of Indian Government has decided to establish the Special Committee for Reorganization and Development of Polytechnic Education for the purpose of reforming its system. This Committee is composed of Indian national members and has decided to draw up a ten-year reorganization plan in the course of six months. The Indian Government asked the Japanese Government, through the Japanese Embassy in India, to send a Japanese adviser to the committee. As the system of polytechnic education is very like that of the technical college in Japan in its school years, it was decided that I should bear the burden of the duty and the Overseas Technical Cooperation Agency despatched me to India in April, 1970. As the abovementioned Special Committee for Reorganization and Development of Polytechnic Education was to start its function in April, 1970, it was requested that the adviser stay in India for a month at the beginning and again for the same length at the close of the six month period and give advice.

I attended various conferences at various places in India (the meetings of the Special Committee for Reorganization and Development of Polytechnic Education, conferences of polytechnic principals, etc.) and inspected some polytechnics, institutes and factories on the schedule drawn up by the Ministry of Education and Youth Services of Indian Government. All through the period of my stay in India every day except Sunday was assigned for conferences or inspections.

Most of the institutes I inspected were established with funds from such advanced countries as West Germany, France, Great Britain and the United States, and the machines and instruments for experiments were those of the countries the funds came from. Many of these installations were on the equal level with those of universities in Japan but some were inferior. The polytechnics have ordinary machine installations to be used for experiments, but these are not adequate for obtaining exact results from experiments. The equipments for experiments seem to be left unused, and I asked how much they were being used, and the answer was that they were not used for teachers' researches nor were the students allowed to handle them. Teachers are afraid I learned, that students who are not accustomed to handling machines may ruin them. For the explanation of machines, demonstration equipments are mainly used. As a result, a lot of demonstration equipments were seen, but many were too crude. The equipments for machine working practice were unsatisfactory. But in the sandwich course polytechnics, the period of practice in the factory is long.

As it seems very difficult for the students trained in this way to obtain a satisfactory professional knowlege and skill, deformation is necessary. In addition to this, the problem of language makes the matter more difficult. There are 14 influential native languages spoken in India, to say nothing of many more lesser ones, and they are foreign languages to each other. English is taken up as a common means of communication and technical education is carried on through English. But some of the students lack basic knowledge of English and class work does not proceed very smoothly. Therefore at the time of entrance into the polytechnic, it is necessary to give lessons in English and make the students fairly competent in the language. This situation in India has no parallel in Japan and English study in India is quite an urgent problem. The level of education at the primary, middle and high schools also seems low. It must be raised.

I inspected factories, both of big and small scales. They were all in good order. I suppose this is because they chose representative factories for my inspection.

Judging from what I learned through my inspection, together with what I saw and heard during my tour in this country, I hold that some fields of Indian industry, by introducing foreign technology of advanced countries, have made considerable progress (*e.g.* by completing its equipment and getting technical guidance through establishment of joint concerns) but much of what has been introduced from advanced countries is not fully utilized. That is to say, though the technical installations may appear to be of first class, they are not necessarily utilized to the full or are apt to be out of order, and the standard of products is not very high. But it is witnessed everywhere that people are making great efforts to catch up with advanced countries as fast as possible. Japan seems to be the best object of their efforts. The case is the same in other fields of industry and in the world of education.

The Special Committee for Reorganization and Development of Polytechnic Education informed me of the system of technical education in India, and I, on my part, explained its Japanese counterpart. A keen interest was accorded to the technical college in Japan, so I will explain it later in details.

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[*] Submitted in January, 1971 through the Overseas Technical Cooperation Agency, Japan.

Places Inspected

I travelled from north to south in the central part of India, making inspections or attending conferences. I mention the names of the places I visited. The Committee or other conferences were held at the places marked with an asterisk.

New Delhi*—Chandigarh—Nangal.

Bhakra Dam—Bangalore*—Hyderabad*.

Madras—Coimbatore*—New Delhi.

Institutions Inspected

Polytechnics	12 places
Institutes	9 places
Factories	13 places

2. *Technical Education in India*

(*i*) *Educational System in India*

The system of the primary and secondary education is nearly the same with that of Japan (cf Fig. 1), and it is made up from the primary school (of 4 school years), the middle school (3 years) and the high school (3 years). Children are taken into the primary school at the age of five. When a student leaves the high school (at the age of 15), two courses are open to him, university or polytechnic. Before going up to a university, a student has to finish the pre-university course. The school years/of the technical university is 5. The polytechnic has three courses of two, three and four (sandwich course) years of which, three years is the normal course and the graduates become diploma holders. In the four year course, the students become 18 years old at the time of graduation. There are some varieties in operating the four year course, but they all belong to the sandwich course and the students are sent to factories for practice during their course of learning. The practice is performed every other month, every two months or six months. Most of the polytechnics set greater intervals between the practice as the school year advances. The sandwich course seems to be more adopted at the private polytechnics than in others. There are two ways of running these affairs; in one case, a factory manager establishes a school, while in the other, a school manager owns and runs a factory for a profit. In either case, the practice is carried in a directly operated factory. It seems this method has been adopted to reduce the running expenses of a school or a factory. So if a student chooses the three year course at the polytechnic, it is 13 years from his entrance into the primary school to the graduation from the polytechnic. It is 14 years in case of the technical college in Japan. In case of the technical high school, also in Japan, it is 12 years. If we compare the school years, the polytechnic comes between the technical college and the technical high school. The age at the time of graduation is 20 at the technical college, 18 at the technical high school, while it is 18 at the polytechnic, the same with the technical high shool in Japan.

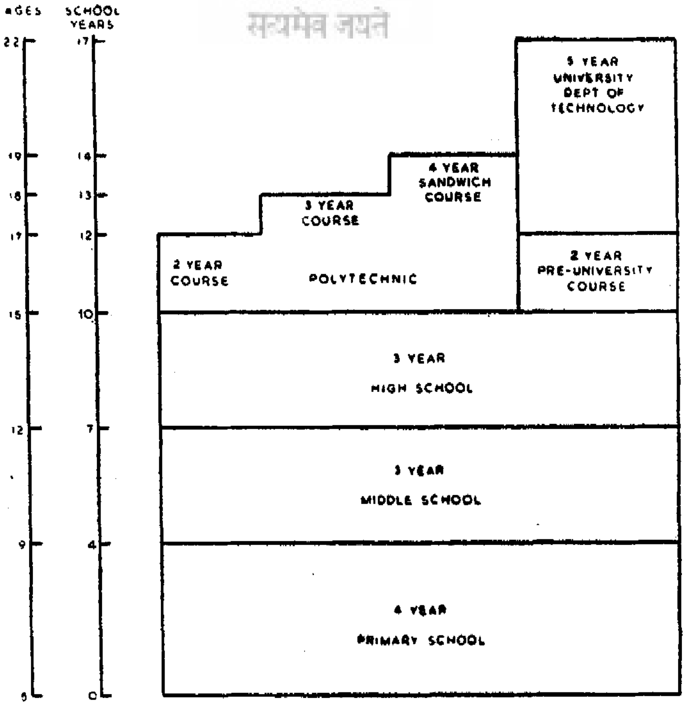

Fig. 1. System of Technical Education in India

(*ii*) *Present Situation and Problems of the Polytechnic*

The age of admission is 15 both at the polytechnic in India and the technical college in Japan. Though it is the same in terms of the age, it is not in terms of the level of primary education received previously; that of India seems lower than that of Japan. The main reason for this difference seems to stem from the language. As there are more than 14 influential native languages in India, English must be used as a common language. But students are not necessarily proficient in English. And this is great obstacle for raising the level of education.

The newly organized Special Committee for Reorganization and Development of Polytechnic Education in India think that a diploma holder of the polytechnic is insufficient in his ability of designing and drafting, or is a poor worker in the factory, in short, he is insufficient as a technician, and that they must find some means to train him into a competent one. The reason of this shortcoming is not merely the shortness of school years compared with that of Japan; the level of the scholastic attainments at the time of admission, the curriculum at the polytechnic and also the substance taught to the students must be re-examined. The teaching method of design and drawing, the contents of experiments and practice and the way to carry them out have their own problems to solve. All the polytechnics have ordinary experiment and practice facilities, in addition to a lot of demonstration equipments, but they are all inadequate for the researches of the teachers. So it seems the teachers do not attempt any research, but devote all their time to the instruction of students. Here we have a serious problem. Teachers do no allow the students to operate the equipments for experiments and make use of the demonstration equipments only. It is impossible to cultivate students' abilities in this way. It is through learning the working of machines by handling them for themselves, examining their efficiency through repeated experiments, not without some blunders at times, that students come to have a real knowledge of machines. It can not be avoided that they sometimes ruin a machine in executing their experiments. Teachers should give them proper guidance so as to prevent breakdown of machines. It is quite necessary that teachers make efforts to gain capability themselves so that they can give adequate instruction to the students. In giving instruction in design and drawing, for example, a teacher should give enough basic knowledge in advance so that the students can get along on their own. A teacher must perform various experiments, study designing and cultivate full capability adequate to teach the students.

The best way to run the polytechnic is to adopt the system of the technical college in Japan. For this purpose, I recommend a reformation of the polytechnic system, without touching the present system of primary education; to set the school years as follows:

Pre-Polytechnic	2 years
Polytecnic	3 years

to give English and other general subjects during the pre-polytechnic years and thus pave the way for the professional education and make the students get enough professional knowledge, technology and skill during the three years of the polytechnic. To start this system, capable teachers must be trained in the first place. Without well-qualified teachers, the object will never be attained.

3. *Technical Education in Japan*

(*i*) *System of Technical Education in Japan* (*cf. Fig.* 2)

In Japan the attendance at the primary school and the lower secondary school is compulsory. Children enter the primary school at the age of six and stay there for six years (till the age of 12), then enter the lower secondary school, finishing the course in three years. After leaving the lower secondary school, pupils can choose either the senior high school (3 years), the technical high school (3 years), or the technical college (5 years). To enter the faculty of engineering in a university (4 years), it is necessary to finish the course of the senior high school. So the age of the students at the time of graduation from these schools is, 18 at the technical high school, 20 at the technical college, and 22 at the faculty of engineering in a university.

As for the substance of instruction, the technical high school gives general, common knowledge of engineering; the technical college and the faculty of engineering in a university give professional knowledge and technology. So, the curriculum of the technical college is more substantial than that of the faculty of engineering, and allots a great deal of time for designing, drafting and practice.

The system of the technical college has recently been brought into existance, and it is only eight years since its creation. But great expectation is being accorded to it from all the fields of industry and demands for the graduates from these fields far surpass the number of the graduates. The industrial world makes it a rule to set no distinctions between the graduates from both these educational institutions, and gives equal chance of promotion according to their ability. It is desirable for those who want to work in the fields of research to go up into the graduate division (bachelor and doctor course) after graduation from university.

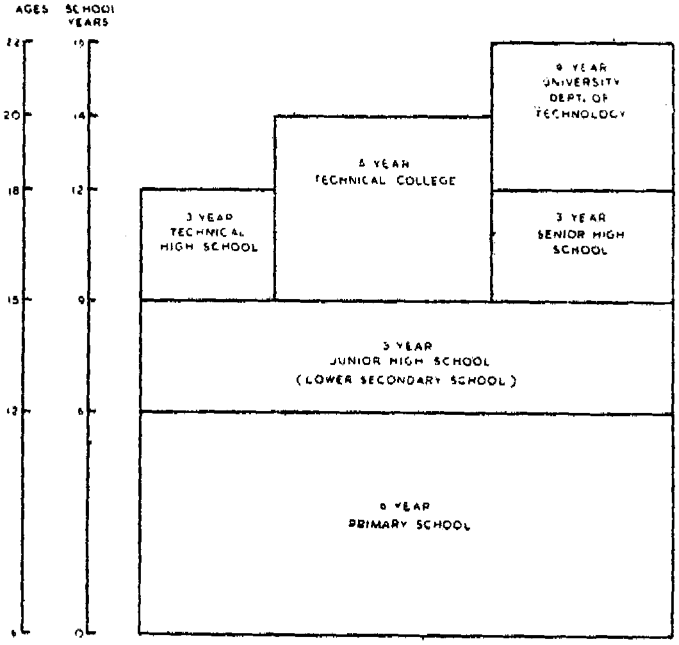
AGES
SCHOOL YEARS
22
20
18
15
12
6
16
14
12
9
6
0
4 YEAR UNIVERSITY DEPT. OF TECHNOLOGY
5 YEAR TECHNICAL COLLEGE
3 YEAR TECHNICAL HIGH SCHOOL
3 YEAR SENIOR HIGH SCHOOL
3 YEAR JUNIOR HIGH SCHOOL (LOWER SECONDARY SCHOOL)
6 YEAR PRIMARY SCHOOL

Fig. 2. System of Technical Education in Japan.

(ii) *Fields Where School and University Graduates Work and Their Pay*

There is no limit as to the fields where the graduates from the technical high school, the technical college, and the faculty of engineering work. Everybody can work wherever he wants to, if he is competent enough, but most of them take the following lines:

Graduates from the technical high school	Workers
Graduates from the technical college	Technicians Engineers.
Graduates from the faculty of Engineering	Technicians Engineers

All the government, public and private schools and universities are equally treated and there is no discrimination made among them.

The initial salary for the new graduates working in the industrial world is, on the whole, as follows:

Graduates from the technical high school	yen 38,000 per month
Graduates from the technical college. .	yen 48,000 „
Graduates from the faculty of engineering	yen 53,000 „

These are the monthly amount including bonus, but it is different in different companies and it is going up every year. The figures shown here are average for April, 1970.

The graduates from the technical college are two years younger than those from the university, and many companies adopt the line of making the salary of the technical college graduates at the time of two years after the graduation equal to the initial salary of university graduates, and after that giving promotion according to each person's ability.

(iii) *Running Expenses of Schools and Universities*

There is a great difference in the operating costs among the faculty of engineering in a university, the technical colleges and other schools according to the status of the founders, *i.e.* government, public and private. Here I show the figures per student at a government school or a school similar to that and can be taken as a standard. They show the yearly running and personnel expenses, and do not include the expenses for facilities and equipments or research aid subsidies.

	Running expenses per student
Technical high school	yen 100,000
Technical college	yen 220,000
Faculty of engineering (University) .	yen 300,000

All the teachers of the high school are simply teachers, but at the technical college and university they are professors, assistant professors and lecturers. The requirement for a high school teacher is to possess a teacher's license. To be professor, assistant professor or lecturer he must have a good scholastic research career, and must be acknowledged as having enough ability to perform his duty. So he is taken into service after personal screening. There is no discrimination made between the teachers of general subjects and those of professional subjects.

The monthly amount of a teacher's salary (the average of 12 months) at the technical college is about 50,000 yen to 150,000 yen plus bonus. He can also receive the benefit of the mutual-aid-co-operative association.

(iv) *Japan Society of Engineering Education*

I am going to describe, for the sake of reference, a brief outline of the activities of Japan Society of Engineering Education which is closely related with technical education in Japan.

Dividing the whole country into seven districts, we have district societies of engineering education (with the name of the district prefixed like Kanto Society of Engineering Education). These societies are organized by the industrial world, faculties of engineering in universities and technical colleges in the area belonging to each district. Integrating all these district societies, we have Japan Society of Engineering Eduaction. So the members of district societies are at the same time members of the integrated society.

These district societies have committees for co-operation between the industry and educational institutions, make investigation into the problems concerning engineering education, and publish the results in the bulletin of each district. These results are utilized as reference data in solving the problems in the industrial world, the faculties of engineering and the technical colleges.

The Japan Society of Engineering Education holds a general meeting once a year and on that occasion the members come to meet from all parts of Japan, and make report on the activities of each district society during the past year and exchange information. In this general meeting we have panel discussions on various problems concerning technical education and exchange our opinions directly. As the details of the progress of these panel discussions are published in the bulletin of the society, absentee members are also able to know the proceeding of the discussions and make use of these data for reference. The Japan Society of Engineering Education organizes a nation-wide committee, when occasion demands, for co-operation between the industry and the educational institutions, and makes a study of various problems concerning engineering education, and on the results obtained, gives advice to the parties concerned.

4. *System of the Technical College in Japan*

(i) *Establishment of the System of Technical College*

In 1947, Japan abolished her old 'double-track" educational system and adopted a so-called "6-3-3-4 singletrack" systeh, *i.e.* six-, three-, three-, and four-years courses of study for the primary school, junior high school, senior high school and the university, respectively. The programme of switching over from the old to the new system started to be put into practice in that same year.

The aim of this new system was to realize equal educational opportunity for the whole nation as should be expected in a democratic state. However, it has come to be realized and argued by the intellectual persons in various fields of life that equal opportunity is not necessarily attained just by simplifying the school system, but rather it will be realized by adopting an educational system well matched with the historical background and various social conditions of the people and opening the way for all the people to receive a suitable education according to their ability.

On the other hand, the economic development of Japan after the War has been quite remarkable, and as a result, qualitative and quantitative shortage of industrial engineers capable of coping with the advanced technology has come to be keenly felt and the argument for their training became very lively. Especially a loud cry was raised from among the industries for establishing a new educational institution for the purpose of training technicians. The Central Council on Education, an advisory body to the Minister of Education, recommended to establish a new organ of technical education of five to six school years, alongside the university, uniting the senior high school and the junior college.

The idea of the technical college was conceived under these circumstances and all the neessary legislative measures were got through the Diet in 1961, and in April 1962 the technical college on this new system was started. Thus, we have a 6-3-5 school year course together with that of 6-3-3-4. In other words, when a pupil plans to enter a school of higher grade after his compulsory education, he can now choose either the course of the technical college or the course of going up to a university by way of the high school.

(ii) *Outline of the Technical College*

The technical college may be said, in short, to be an institution of higher education, the prerequisite for admission being graduation from the junior high school, which aims at bringing up technicians on an intensely and systematically constructed five year educational programme.

While in case of the old 6-3-3-4 school year system, technical education is centered in the last two years, the technical college has this characteristic that the students are given technical education alongside general, basic education. This is very important in view of the fact that future technicians are required to have a comprehensive thinking faculty as well as expert knowledge and skill. This is because cultivation of various categories of technical skill should be started while young. In this sense, the technical college is quite a new and different institution compared with the old high schools and colleges.

As to the laws and regulations concerning the technical college, the School Education Law, School Education Enforcement Law and its Enforement Regulations provide the details, but the standards of the educational facilities, teaching personnel and curriculum are prescribed in the Technical College Establishment Standard. With special reference to these laws and regulations, I will describe the outline of the technical college.

(A) *The Aim of the Technical College*

The technical college aims to "teach highly professional knowledge and cultivate abilities necessary for vocation." (Article 70-2, School Education Law).

While the high school aims at "giving liberal education", the technical college is an institution for higher vocational education and aims at "teaching highly professional knowledge" in its five school years. Thus, the technical college has a different aim from that of the high school, and attaches special importance, among its subjects, to practical training and experiments. The subjects which outwardly look like the same with those of the high school are, in fact, specially prepared, in case of the technical college, to be highly effective as the basis of technical education, and not merely as an item of general education. This is one of the reasons the graduates from the technical college have a great demand from the industrial world. (100 per cent employment every year).

From the above statement, some people might have apprehensions that, even though highly professional knowledge and technical skill may be attained in the technical college, it might have a weak point in moral education and produce technicians poor in comprehensive thinking faculty which is another indispensable requirement in those who would be leaders in society. It is true that in the old educational system there was a tendency, from the viewpoint of emphasising moral education, to lay greater importance upon general rather than professional education. But character building or cultivation of a comprehensive thinking faculty can not be accomplished only through general education. An old saying goes, "One who is proficient in one art has a sense for all arts," which is quite true. The technical college aims at character building through professional education. 'No one's aptitude is the same with others'; those who do not like experiment and shop training by nature can not utilize the professional education in the technical college for character formation. So those who consider the general education in the high school more valuable for character building should not choose the way to the technical college.

In short, the technical college may be defined as an educational organ intended for those who consider that it is better for character building to choose and begin to absorb, as early as possible, such kind of knowledge as may contribute for cultivating professional capability and then, after acquiring professional knowledge and technical skill, proceed to enlarge and improve this kind of knowledge and skill, than to acquire knowledge merely for refinement or to acquire professional knowledge on this basis of cultural knowledge or encyclopaedic knowledge.

(B) *Kinds of Course and Number of Technical Colleges*

The principal courses of study currently offered to the students at the government technical colleges are the courses of mechanical engineering, electrical engineering, industrial chemistry, civil engineering, architecture, metal engineering, etc., but in some of the public and private colleges, such special courses as aircraft body engineering and printing engineering are also offered. The details are shown in Table I.

The total number of the technical colleges in Japan as of 1970 is shown below:

Government technical colleges	44
Public technical colleges	4
Private technical colleges	7

("Public" here means "prefectural" or "municipal.")

TABLE I. *Classification of Bounders, Courses of Study and Number of Courses and Classes.*

Course of Study	Total		Government		Public		Private	
	A	B	A	B	A	B	A	B
Dept. of Mechanical Engineering	54	84	44	62	4	10	6	12
Dept. of Production Machinery Engineering	1	1	1	1	..	..	..	..
Dept. of Electrical Engineering	53	60	44	44	3	4	6	12
Dept. of Electronic Engineering	2	2	2	2	..	..	..	..
Dept. of Industrial Chemistry	29	29	25	25	2	2	2	2
Dept. of Chemical Engineering	3	3	3	3	..	..	..	..
Dept. of Civil Engineering	27	29	23	23	2	2	2	4
Dept. of Architecture	12	13	11	11	..	..	1	2
Dept. of Metal Engineering	6	6	6	6	..	..	..	..
Dept. of Aircraft Body Engineering	1	1	..	..	1	1	..	..
Dept. of Aircraft Engineering	1	1	..	..	1	1	..	..
Dept. of Printing Engineering	1	2	..	..	..	..	1	2
Dept. of Industrial Designing	1	1	..	..	..	..	1	1
TOTAL	191	232	159	177	13	20	19	35

A : Number of Courses
B : Number of Classes

(as of 1970)

(C) *School Years*

The required length of period of school attendance is five years for the graduates from the lower secondary school. From the point of school years this is equal to the period of three years of the senior high school plus the first half of the four year university or the two years of the junior college. But as for the substance of education, it is quite different from that of any of these. The curriculum is systematically organized to make the best use of the five years, and substantial professional education is performed while giving at the same time effective general education. Accordingly, the technical college adopts, unlike the university, not the point system, but the school year system.

(D) *Teaching and Business Staffs*

The teaching and business staffs of the technical college, as an institution of higher education, are composed, following the example of universities, of the director, professors, lecturers and assistants and clerical personnel; part-time lecturers and technical employees can also be employed, if necessary.

To take a government college for example, in case of a school with four courses, one class for each course (fixed number of admission for a school year, 160; total fixed number 800), there are to be, under the director, 20 professors, 18 assistant professors, 9 lecturers and 13 assistants as the teaching staff, and 80 persons as clerical personnel and technical employees in the business staff; the sum total of the teaching and business staffs is 141 persons under the director.

Teachers of the technical college require highly professional knowledge, just as those at the university, and the Teaching Profession License Law is not applied to them. They are taken into service through screening according to the standard of qualification for professors, assistant professors, lecturers and assistants laid down in the Technical College Establishment Standard, as it is the case in universities.

In each college, when they organize the teaching staff, they try to secure adequate teachers from all fields of education and industry, *i.e.*, persons with experiences in universities or in high schools and competent technicians in the industrial world, and to produce good educational effects by making best use of their merits.

(E) *Curriculum of the Technical College*

As to the curriculum, a detailed explanation will be made later, so I will lightly touch it here from the point of system.

The curriculum is to be organized in the frame of the number of school days, the subjects to be taught and the number of class hours for each subjects laid down in the Technical College Establishment Standard. According to the provisions, the number of school days is, as a rule, 35 weeks, *i.e.,* 210 days a year, and the total class hours over five years should be 6,545 hours. Of these, the class hours for general subjects (excluding 105 class hours for special curricular activities) is 2,975, and so, as far as general education is concerned, the number of 2,975 is much smaller than the number of class hours of the general subjects at the high school and university combined (about 4,450). But as to the general education in the technical college, the subject are taught in good systematic arrangement in the course of five years without overlapping or repetition, unlike at the high school and university. Moreover special emphases is laid upon giving that sort of culture and insight necessary for technicians, and so the difference between the two is more apparent than real.

Next, the total class hours for the technical subjects is 3,640, which surpasses those of universities (3,000—3,200 hours). Moreover, while almost all technical education in universities is performed in the last two years and a half out of the four school years, in the technical college it is performed all through the five years. As a result, very satisfactory educational effects are expected and substantial professional education, almost of the same level with that of universities, is performed.

(F) *Educational Facilities of the Technical College*

As to the site of the technical college and the scale of the school buildings, the lowest necessary standard is prescribed in the Technical College Establishment Standard, and great care is taken to secure the required level of education. In the government technical college, especially, in view of an expansion of the school scale to that of five or six departments in the future, a site of about 100,000 square meters is secured as well as modern-styled school buildings and practice shops suitable for effective education, together with a well-accommodated dormitory, a gymnasium and outdoor athletic facilities, which aim to contribute to the welfare of the students.

Special consideration is paid to install such facilities and equipments as are necessary for giving effective technical and general education.

(G) *Admission into University*

The technical college is a self-completed organ of education and is not a preparatory school to the university, but for those students who desire to pursue their study in the university, a way is open for admission. It is provided in the School Education Law that a graduate from the technical college may be admitted into a university according to what may be determined by the competent authorities, and that the period of attendance may be two years less than that prescribed for ordinary students. (School Education Law, Article 70-8. Seventy-nine persons were admitted into universities in 1968.)

In addition to these measures, a plan is being studied of a new College of Industrial Technology (a tentative name), which will cater for the technical college graduates after they have had at least two years' experience in industry.

(*iii*) *Curriculum of the Technical College*

The general principles in organizing the curriculum of the technical college are prescribed in the Technical College, Establishment Standard laid down by the Ministry of Education, and the details of distribution of the teaching subjects through the school years and the substance of what should be taught are provided in the Standard of the Technical College Curriculum, and each college is to organize its curriculum according to these.

Educational Objectives of the Technical College

The technical college aims at training technicians with rich culture and ample professional knowledge through systematic instruction extending over five years.

To attain this object, the technical college sets up folowing items as the means to it:

(A) To give general culture necessary for a number of society and cultivate humanity.

(B) To make the students acquire the basic knowledge and skill necessary for designing, production, building and management, as well as planning and execution of test, reasearch and investigation, and thus cultivate the indispensable ability for a technician.

(C) To cultivate comprehensive judgment and originality concerning technology.

(D) To cultivate the spirit of co-operation, sense of responsibility and faculty of leadership.

(E) To build the physical foundation of health and cultivate the ability to maintain and improve health.

(F) To cultivate a sympathetic attitude to all sorts of cultures in the world, and a keen and broad interest in international society.

The following tables show the subjects to be taught and allotment of lesson hours to each school year, as prescribed in the Standard of the Technical College Curriculum.

I. GENERAL SUBJECTS

(Common to all professional courses)

Subjects		Total of per week class hours	Class hours per week for each academic year.					Notes
			1st year	2nd year	3rd hear	4th year	5th year	
Humanities	Japanese	9	3	3	2	1		Present Japanese as fundamentals, with some addition of classics
	Ethics & Philosophy	2				2		
	History	4	1	1	2			
Social Studies	Geography	2	2					
	Law & Economics	4				2	2	
Natural Science	Mathematics	18	6	6	6			
	Physics	5	2	3				
	Chemistry	5	3	2				5 for the 1st, 0 for 2nd year students in case of the Departments of Industrial Chem. and Metal Engineering.
Health & Physical Education		10	3	3	2	1	1	
Arts		2	1	1				
Foreign Languages	English	18	6	5	3	2	2	
	2nd For. Lang.	6		2	2	2		
Total		85	27	26	17	10	5	29 for the 1st, 24 for the 2nd year in case of the Departments noted above.
Special Curricular Activities		3	1	1	1			
Sum Total		88	28	27	18	10	5	30 for the 1st, 25 for the 2nd year in case of the Depts. noted above.

II. PROFESSIONAL SUBJECTS

Department of Mechanical Engineering

Subjects	Total of per week class hours	Class hours per week for each academic year					Notes
		1st year	2nd year	3rd year	4th year	5th year	
Applied Mathematics	4			4			Exercise included
Applied Physics	5		3	2			Exercise & Experiment included
Graphics	2	2					Exercise included
Mechanism of Machinery	2		1	1			Exercise included
Engineering Dynamics.	2			2			Exercise included
Strength of Materials	6			2	2	2	Elastic and Plastic, Dynamics and Testing of materials included.
Engineering Thermodynamics	2				2		Exercise included
Hydraulics	2				2		Exercise included
Outline of Electrical Engineering	4			2	2		Electronic included
Machining Technology	4			2	2		
Metallic Materials	4		2	2			
Design of Machines	3			1	2		
Machine Design and Drawing	18	3	3	3	3	6	
Engineering Experiment	7				3	4	Mechanical & Electrical Engg. Experiment
Machining Practice	9	3	3	3			
Elective Subjects	22				5	17	
Graduation Thesis	6					6	
Total of Professional Subjects	102	8	9	21	29	35	
Total of General Subjects	88	28	27	18	10	5	
Sum Total	190	36	36	39	39	40	

Elective Subjects (Elected by the school and given to the students as required subjects)

- Mechnical Dynamics.
- Vibration Engineering.
- Steam Power Engineering
- Motor Engineering
- Machine Tools.
- Automatic Control
- Lubrication Engineering
- Plastic Processing.
- Analysis of Apparatus.
- Special Lectures.
- Heat Transfer
- Internal Combustion Engines
- Hydraulic Machinery
- Hydrodynamics
- Production Engineering
- Technical Measurement
- Non-metal Materials.
- Outline of Chemical Engineering
- Technical Foreign Language
- Others.

Department of Electrical Engineering

Subjects	Total of per week class hours	Class hours per week for each academic year					Notes
		1st year	2nd year	3rd year	4th year	5th year	
Applied Mathematics	4				4		Exercise included
Applied Physics.	5			3	2		Exercise and Experiment included
Graphics	2	2					Exercise included
Electricity and Magnetism	4		2	2			
Theory of Alternating Current	4		1	2	1		
Electrical Measurement	3			2	1		
Electronics	3			1	2		
Electric Circuit Theory	2					2	
Outline of Mechanical Engineering	8		2	4	2		
Electrical Machinery and Apparatus	6			3	3		
Material for Electrical Engineering	3				2	1	
High Voltage Engineering	2				2		
Design of Electrial Machinery	4				2	2	
Electrical Drawing	6	4	2				
Experiment and Practice of Electrical Engineering	18	2	3	3	4	6	
Elective Subjects	22			1	4	17	
Graduation Thesis	6					6	
Total of Professional Subjects	102	8	10	21	29	34	
Total of General Subjects	88	28	27	18	10	5	
Sum Total	190	36	37	39	39	39	

Elective Subjects (elected by the school and given to the students as required subjects)

- Electric Power Generation and Transformation
- Transmission and Distribution of Electric Power
- Application of Electrical Engineering
- Illumination and Electric Heating
- Application of Electric Motors
- Electric Railway Engineering
- Outline of Electro-chemistry
- Automatic Control
- Electronic Circuit
- Electronic Measurement
- Electrical Communication
- Semi-conductor Engineering
- Production Engineering
- Laws and Regulations concerning Electricity and Electric Waves
- Technical Foreign Language
- Special Lectures
- Others.

Department of Industrial Chemistry

Subjects	Total of per week class hours	Class hours per week for each academic year					Notes
		1st year	2nd year	3rd year	4th year	5th year	
Applied Mathematics	4				4		Exercise included
Applied Physics	5			3	2		Exercise and Experiment included
Graphics	2	2					
Inorganic Chemistry	3		2	1			
Organic Chemistry	3		1	2			
Physical Chemistry	4			2	2		
Analytical Chemistry	2		2				
Chemical Engineering	6				2	4	
Material Engineering	2				2		
Outline of Mechanical Engineering	4		2	2			
Outline of Electrical Engineering	4			2	2		
Inorganic Industrial Chemistry	3				2	1	
Organic Industrial Chemistry	3				2	1	
Design and Drawing in Industrial Chemistry	6	2	2	2			
Experiment of Industrial Chemistry	21	2	3	5	7	4	
Elective Subjects	20			1	4	15	
Graduation Thesis	10					10	
Total of Professional Subjects	102	6	12	20	29	35	
Total of General Subjects	88	30	25	18	10	5	
Sum Total	190	36	37	38	39	40	

Elective Subjects (elected by the school and given to the students as required subjects)

- Synthetic Chemistry
- Polymer Chemistry
- Analysis of Apparatus
- Petroleum Chemistry
- Industrial Electro-chemistry
- Rheology
- Organometallic Materials
- Measurement and Control
- Thermodynamics
- Hydraulics
- Theory of Transfer
- Solid State Physics
- Safety Engineering
- Production Engineering
- Experiment of Mechanical Engineering
- Experiment of Electrical Engineering
- Technical Foreign Language
- Special Lectures
- Others.

Department of Civil Engineering

Subjects	Total of per week class hours	Class hours per week for each academic year					Notes
		1st year	2nd year	3rd year	4th year	5th year	
Applied Mathematics	4				4		Exercise included
Applied Physics	3			3			Exercise and Experiment included
Graphics	2	2					
Engineering Works Materials	2		2				
Applied Mechanics	5			3	2		
Structural Mechanics	5				3	2	
Hydraulics	5			3	2		
Surveying	5	2	2	1			
Engineering Geology	2		2				
Soil Engineering	3			3			
Execution of Engineering Works	2				2		
Bridge Engineering	4				2	2	
Reinforced Concrete Engineering	4			2	2		
Outline of Mechanical Engineering	2				2		
Outline of Electrical Engineering	2					2	
Design and Drawing in Civil Engineering	14	2	2	2	2	6	
Experiment and Practice of Civil Engineering	14	2	3	3	3	3	Experiment in Engineering Works Materials, Structural Mechanics, Hydraulics, Surveying, Soil Engineering, Execution of Engineering Works, Sanitary Engineering
Elective Subjects	18				5	13	
Graduation Thesis	6					6	
Total of Professional Subjects	102	8	11	20	29	34	
Total of General Subjects	88	28	27	18	10	5	
Sum Total	190	36	37	38	39	39	

Elective subjects (elected by the school and given to the students as required subjects)

- Sanitary Engineering
- Outline of Architecture
- River and Water Resources Engineering
- Road Engineering
- Railroad Engineering
- Harbor and Waterfront Engineering
- Water-power Generation and Dam Engineering
- Earthquake-proof Engineering
- Area and City Planning
- Sand Guard Engineering
- Building Machinery
- Metallic Materials
- Industrial Gunpowder
- Laws and Regulation concerning Civil Engineering
- Engineering Works Management
- Technical Foreign Language
- Special Lectures
- Others.

Department of Architecture

Subjects	Total of per week class hours	Class hours per week for each academic year					Notes.
		1st year	2nd year	3rd year	4th year	5th year	
Applied Mathematics	4				4		Exercise included.
Applied Physics	3			3			Exercise and Experiment included
Graphics	2	2					Exercise included
Modelling	4	2	2				
Building Construction Mechanics	6		2	2	2		Exercise included
General Building Construction	3	2	1				
Building Materials	4		2	2			Exercise and Experiment included
Surveying	2					2	Practice included
Outline of Mechanical Engineering	2				2		
Outline of Electrical Engineering	2					2	
Steel Construction	4				2	2	Exercise included
Reinforced Concrete Construction	4				2	2	Exercise included
Building Construction Planning	4				2	2	Exercise and Experiment included
Building Planning	9			4	3	2	Exercise and Exeperiment included
Building Design and Drawing	23	2	3	6	6	6	
Elective Subjects	20			4	6	10	
Graduation Thesis	6					6	
Total of Professional Subjects	102	8	10	21	29	34	
Total of General Subjects	88	28	27	18	10	5	
Sum Total	190	36	37	39	39	39	

Elective Subjects (Elected by the school and given to the students as required subjects)

- History of Architecture
- Applied Mechanics (Vibration, Elasticity)
- Execution of Building Works
- Area and City Planning
- Architectural Design.
- Laws and Regulation concerning Buildings
- Building Utilities.
- Soil Foundation Engineering.
- Anti-calamity Engineering
- Technical Foreign Language
- Special Lectures.
- Others.

Department of Metal Engineering

Subjects	Total of per week class hours	Class hours per week for each academic year					Notes
		1st year	2nd year	3rd year	4th year	5th year	
Applied Mathematics	4				4		Exercise included
Applied Physics	5			3	2		Exercise and Experiment included
Graphics	2	2					Exercise included
Physical Chemistry	3			3			Exercise and Experiment included
Analytical Chemistry	3		3				Experiment included
Metal Analysis.	1			1			
Outline of Mechanical Engineering	4			2	2		
Outline of Electrical Engineering	4			2	2		
Physiometallurgy	4			2	2		
Smelting	4			2	2		Iron Smelting, Non-iron Smelting and Special Metal Smelting.
Metallophysics	2				2		
Theory of Smelting	2				2		
Metallic Materials	4				4		Steel, Non-iron Materials and Special metal Materials
Metal Processing	6				4	2	Machining, Plastic. Processing, Casting, Welding and Powder Smelting
Design and Drawing in Metal Engineering	7	2	3			2	
Experiment and Practice in Metal Engineering	21			6	3	12	
Elective Subjects	20	2	4		2	12	
Graduation Thesis	6					6	
Total of Professional Subjects.	102	6	12	21	29	34	
Total of General Subjects	88	30	25	18	10	5	
Sum Total	190	36	37	39	39	39	

Elective Subjects (elected by the school and given to the students as required subjects)

- Strength of Metals (Strength of Materials, Method of Materials Testing, etc.)
- Outline of Metal Engineering (History of Metals, Separation of Ores, Refractory Materials against Fuels, Metallurgical Outline of Smelting and Processing Materials, etc.)
- Metal Chemistry (Anti-erosin of Metals, Processing of Metal Surface)
- Outline of Chemical Engineering
- Stochastics
- Technical Measurement
- Analysis of Apparatus
- Automatic Control
- Machining Technology
- Electrical Engineering Practice
- Production Engineering (Quality Management, Safety Engineering, Factory Management, Factory Construction, Industrial Administration)
- Technical Foreign Language
- Special Lectures
- Others.

5. *Advice to the Special Committee for Reorganization and Development of Polytechnic Education*

From what I have come to know through my inspection and observation of Indian institutes, polytechnics and industrial factories, from the explanations they gave me about these and from what I learned through discussion at the conferences at Bangalore and Hyderabad, I list here several points which I consider should be reformed in the polytechnic education, and tender the following advice to the Committee.

(i) *Reorganization of Educational System*

First, it is necessary to raise the level of elementary and secondary education at the primary, middle and high school and then that of the polytechnic; that is, to examine the system of elementary and secondary education and raise its level. If this necessitates too much preparation to be practicable, I recommend the following reorganization of the system. This is my proposal; to establish 2 years system pre-polytechnic, and admit into the polytechnic only those high school graduates who finished the course of the pre-polytechnic. In this case, there is no need to attempt any change in the present system of elementary and secondary education. At the pre-polytechnic, English and other general subjects which are basic for professional education should be taught, and the whole period of the polytechnic should be devoted to professional education. The first thing to do, to carry this plan into practice, is to train the teachers.

(ii) *Improvement of the Quality of Teachers*

Competent teachers are the first requirement for attaining the objectives set up for the polytechnic education. To be a competent teacher, the teacher himself must always try to improve himself. This makes it necessary for him to be always going ahead with his researches (both in theoretical and experimental fields) and publish the results in bulletins or elsewhere.

I was told, when I was inspecting a certain polytechnic, that the teachers had no time to spare for their study. I do not think this is very convincing. I am afraid they do not, perhaps, make serious efforts to find time for their study. Teachers can hope to improve themselves by going ahead with their researches. It goes without saying that most research work necessarily accompanies considerable difficulty and demands invention and efforts.

(iii) *Cultivation of the Teaching Ability of Teachers*

To teach the students, a teacher must have an ample professional knowledge about what he teaches, make a research on teaching methods and contrive means to deal with the difference of abilities on the part of the students. To increase his professional knowledge, the scientific researches he is making will be of great help to him. To guide the students in experiments, designing and drawing, the teacher must first be able to execute these himself. He must always have a full understanding of the students' standpoint, and contrive to make the students better grasp what he teaches.

(iv) *Teaching Methods*

Teaching methods should aim at intelligibility. In teaching, what and how to teach is more important than to have abundance of time. Teachers should give consideration to the fact that students' abilities are different, one from another. Next, I will explain how to teach professional subjects.

(A) *Lecture*

When the students have fully understood the theories, show them the practical mechanism and movement of machines through demonstration facilities. In this case, show real machines. Remember to make use of what has been taught in the lectures, in designing, drawing, experiments and practice.

(B) *Designing and Drawing*

To cultivate the ability of designing, it is necessary that the students should have a mental vision of the structure, mechanism and performance of the machine to be designed, by making full use of the knowledge obtained through lectures, and that they should make reckoning of the dimensions and the strength of each part and choose the materials. In designing, it is also to be learned that not all the dimensions can be obtained only through calculation. To show good reference drawings is also necessary in drafting. In all these, teachers' readiness to give timely advice and suggestion to make the students correct the drawing while it is being executed, greatly expedites students' progress in the work. Also give each student different data, so that he will make spontaneous efforts.

(C) *Experiment*

Before executing an experiment, the teacher must give preparatory knowledge about its proceedings. Give pertinent suggestions so that the student can make good use of the knowledge gained from the lectures. At the same time, give a detailed lecture on how to write a report, how to deal with the results of an experiment and how to make a conclusion.

In executing an experiment, the students themselves must handle the machines and instruments and take the readings. In this way, they will become able to write a report and corroborate the knowledge gained from the lectures. No matter how the teachers guide the students to prevent them from ruining the experiment facilities, more or less damage will not be avoided.

This kind of experiment must be imposed on all the students assigned to several rooms where different experiments are executed.

(D) *Practice*

Before starting practice, give enough preparatory knowledge by explaining what is going to be done and the methods of execution. In practice, it is necessary to repeat the same operation very often so that the students can attain proficiency in the work to some extent. For that purpose, considerable amount of time will be necessary.

(v) *Out-of-Campus Practice*

It is necessary to have the students, except those of the sandwich course, experience, while yet at school, the factory life in the industrial world. Use summer or other holidays for this purpose. It is desirable to set the term, at least, at 3 to 4 weeks. But practice in the factory cannot be done without the co-operation of industry.

(vi) *Establishment of Engineering Education Research Society of India*

I recommend to set up an industrial and academic worlds co-operative organ for the research of engineering education in India, following the example of Japan Society of Engineering Education, or district societies of the same, and make a research for the development of engineering education and exchange opinions between the industrial and educational worlds.

If people belonging to the industrial world, to universities and polytechnics should have a periodical meeting in each province in India and make research on technical education, it will gather great weight. At present, industries, universities and polytechnics are all isolated. If such a society as mentioned above is organized, what industries demand, and what problems universities and polytechnics are working at, will bocem better comprehended and both will be able to come to a better mutual understanding, with a result co-operative solution of the problems.

When such a society is set up in each province, it will become possible to organize an All India Research Organ of Engineering Education. Then, there will be a good hope of raising, through the concerted efforts of the society, the interest of the Government and the whole people of India about this matter of technical education, and finally achieving the aforesaid re-organization of the educational system.

APPENDIX IV

Survey of Technical Education Facilities in India 1969.

Diploma Courses in Engineering and Techology

A significant development in the field of technical education during the year 1968 was the decision to reduce admissions to technical institutions in the country. In early 1968, it was evident that unemployment among technical personnel had become acute and that immediate steps were necessary to regulate admissions to technical institutions so that the gravity of unemployment in future years could be minimised. Accordingly, in February, 1968. the Ministry of Education advised the State Governments, Univeristies and other authorities to reduce admissions to technical institutions on a selective basis. An overall reduction of 30 per cent in the admission capacity to degree and diploma institutions was suggested. However, the actual reduction was to be implemented in each institution according to the physical facilities available.

The suggestion was generally welcomed by the State Governments and Universities although there was resistance to any reduction in the admissions by some State. However, the position that emerged at the end of the year was that there was a sharp fall in the demand for admissions to both engineering colleges and polytechnics. To assess the position, in 1968, information was collected specially about the number of applicants to engineering colleges and polytechnics for the year 1967 and 1968. The following table shows the result of this Survey:

	Engineering Colleges		Polytechnics	
	1967	1968	1967	1968
No. of Applicants	1,45,174	98,690	1,25,575	66,053
Actual Admissions	24,571	18,445	42,600	27,254

There was a sharp fall both in the case of the number of applicants and the number actually admitted to diploma courses in 1968. In several States, no fresh admissions were made to certain polytechnics. As the problem of unemployment continued to be acute and the indications were that unemployment would persist till the end of the Fifth Plan, the Ministry of Education advised all State Governments and other authorities in June, 1969 that the reduced level of admissions of 1968 should be maintained in 1969 and later till the position improved.

The total number of institutions included in this report is 277. The sanctioned admission capacity was 48579 in 1966. There has been no expansion since then. On the other hand, as a result of some marginal adjustments made in some institutions in 1967, the total admission capacity came down to 47,120. Following the decision to reduce admissions in 1968, the admission capacity came down further. In this Survey Report the sanctioned admission capacity has been shown in respect of most of the institutions at the 1967 level, but in certain cases, the reduced level agreed to by the Institutions has been shown against them. On this basis the total admission capacity in 1969 is 43,082. The actual admissions, however are 26,259.

The output of diploma holders during the year 1969 (at the end of the academic year 1968-69) is 21,545. The subject-wise distribution of sanctioned admission capacity, actual admissions and outturn for diploma courses in 1969 is as follows:

Subject	Sanctioned Admission Capacity	Actual Admissions	Out-turn
Civil Engineering	13,093	6,402	4,812
Mechanical Engineering	14,505	9,194	8,905
Electrical Engineering	11,904	7,460	6,035
Tele-communication/Radio Engineering/Electronics	330	290	223
Mining Engineering	218	154	95
Metallurgy	165	166	86
Automobile Engineering	452	414	243
Textile Technology	478	413	280
Textile Chemistry	55	55	49
Leather Technology	145	112	59
Paper & Pulp Technology	90	40	54
Printing Technology	385	409	207
Commercial Practice	215	190	6
Chemical Operators/Chemical Engineering	250	220	147
Pharmacy	526	478	219
Ceramic Technology	36	34	24
Sound Engineering	60	68	23
Refrigeration	40	59	35
Production Engineering	..	6	9
Industrial Engineering	..	6	5
Architectural Assistantship	85	68	11
Town Planning	20	20	18
Construction and Structure	20	1	..
Industrial Electronics	10	10	..
TOTAL	43,082	26,259	21,545

Table I gives the list of facilities relating to diploma courses, institution-wise and subject-wise including sanctioned intake, actual admission and out-turn for 1969. Table II is a State-wise and subject-wise summary.

The following institutions did not make any admissions to any course in 1969:

1. Government Mining Polytechnic, Tumsar (Maharashtra).

2. Government Leather Technological Institute, Morar, Gwalior.

(Annexures III shows the list of courses not of a regular pattern.

2-Year Technician Courses

The following four institutions with an admission capacity of 600 seats are conducting two-year Technicians courses:

Andhra Pradesh	
1. Andhra Polytechnic, Kakinada	210
2. Government Polytechnic, Hyderabad	270
West Bengal	
1. Asansol Polytechnic, Asansol	60
2. Birla Institute of Technology, Calcutta	60
TOTAL . . .	600

Sandwich Courses

The following 8 institution are offering standwich courses :

Name of Polytechnic	Sanctioned Intake	Actual Admissions made	Outturn
1. Y.M.C.A. Institute of Engineering, Faridabad (Haryana)	75	75	..
2. Birla Institute of Technology, Calcutta	50	13	23
3. Calcutta Technical School, Calcutta	280	96	250
4. State Technological Institute, Rourkela	60	87	39
5. Government Polytechnic, Vishkapatnam	30	30	10
6. Central Polytechnic, Madras	42	42	31
7. Tamilnadu Polytechnic, Madurai	50	..	18
8. Coimbatore Institute of Technology, Coimbatore	60	49	24
	647	392	395

Part-time Courses

Part-time diploma courses are being conducted at 26 institutions including the four schools of Printing Technology. The total admission capacity of the Part-time courses is 1810. A list of institutions which conduct Part-time courses is at Annexure IV.

Girls' Polytechnics and Rural Institutions

In addition to the 277 Polytechnics there are 22 Girls' Polytechnics in the country. A number of these polytechnics are conducting courses like, Electrical Communication/Radio Engineering/Electronics, Architectural Assistant-ship, Civil Engineering and Pharmacy etc. etc. There are also 9 Rural Institutions in the country conducting diploma courses in Civil and Rural Engineering. A list of Rural Institutions and Girls' Polytechnics is given separately at Annexure I and Annexure II. If these institutions are also taken into account the overall admission capacity, actual admissions and out-turn for diploma courses in engineering and technology in 1969, are as follows:

Types of Institution	Sanctioned Admission Capacity	Actual Admissions	Out-turn
1. Diploma Institutions	43,082	26,259	21,545
2. Girls' Polytechnics	2,230	1,953	757
3. Rural Institutions	370	231	246
TOTAL	46,282	28,443	22,548

List of Abbreviations

S.G.	State Government Institution
U.	University Institution
P.	Private (Non-Government) Institution
Civil	Civil Engineering
Mech.	Mechanical Engineering
Elec.	Electrical Engineering
Tele-Comn.	Tele-Communication Engineering
Elec. Comn.	Electrical Communication Engineering
Radio	Radio Engineering
Electronics	Electronics Engineering
Min.	Mining Engineering
Meta.	Metallurgy
Chem.	Chemical Engineering
Auto.	Automobile Engineering
Pharm.	Pharmacy
Text. Tech.	Textile Technology
Text. Chem.	Textile Chemistry
Leath. Tech.	Leather Technology
Prtg.	Printing Technology
Ceram. Tech.	Ceramic Technology
Sound	Sound Engineering
Prodn. Engg.	Production Engineering
Chem. Operators	Chemical Operators
Archl. Asstt. ship.	Architectural Assistanship

TABLE I

TECHNICAL INSTITUTIONS IN INDIA CONDUCTING DIPLOMA COURSES IN ENGINEERING AND TECHNOLOGY 1969

Serial No.	Name of the Institution (Administrative Control) Year of Establishment	Field of study	Sanctioned Admission capacity	Actual Admissions made	Out-turn	Remarks
1	2	3	4	5	6	7
	NORTHERN REGION					
	Delhi					
1	Govind Ballabh Pant Polytechnic, Okhla (S.G.)—1961	Civil	60	60	19	
		Mech.	150	90	72	
		Elec.	90	60	41	
		Auto	30	30	16	
			330	240	148	
2	Pusa Polytechnic, Pusa (S.G.)—1962	Civil	60	60	25	
		Mech.	90	90	103	
		Elec.	60	60	46	
		Pharm.	66	66	..	
		Comm. Practice	60	60	..	
			336	336	174	
3	Kashmere Gate Polytechnic, Delhi (S.G.)—1964	Civil	30	21	18	
		Mech.	90	51	52	
		Elec.	60	57	36	
		Electronics	60	28	35	
			240	157	141	
	Jammu & Kashmir					
4	Kashmir Government Polytechnic, Srinagar (S.G.)—1958	Civil	60	..	..	The results awaited. The Institute closed by J & K Government
		Mech.	30	..	..	
		Elec.	30	..	..	
			120	..	..	
5	Governmnt Polytechnic, Jammu (S.G.)—1960	Civil	15	11	24	
		Mech.	15	10	39	
		Elec.	15	10	29	
		Auto-(Post-Diploma)	15	15	9	
			60	46	101	
	Himachal Pradesh					
6	Government Polytechnic Sundernagar, Mandi (S.G.)—1959	Civil	30	43	35	
		Mech.	45	..	..	
		Elec.	45	30	32	
			120	73	67	
7	Government Polytechnic, Hamirpur (S.G.)—1963	Civil	60	21	6	
		Mech.	60	15	9	
		Elec.	60	15	35	
			180	51	50	

1	2	3	4	5	6	7
Chandigarh						
		(*a*) *Full-time course*				
8	Central Polytechnic, Chandigarh (S.G.)—1959	Civil	45	33	21	
		Mech.	90	48	81	
		Elec.	45	33	44	
			180	114	146	
		(b) *Part-time course*				
		Civil	30	..	8	
Haryana						
9	Haryana Polytechnic, Nilokheri (S.G.)—1958	Civil	90	54	28	
		Mech.	120	67	87	
		Elec.	90	54	62	
			300	175	177	
10	Government Polytechnic, Jhajjar (S.G.)—1961	Civil	45	16	18	
		Mech.	90	32	39	
		Elec.	45	16	35	
			180	64	92	
11	Government Polytechnic, Ambala (S.G.)—1955	Civil	120	70	19	
		Mech.	90	47	51	
		Elec.	90	47	68	
		Auto	30	23	19	
			330	187	157	
12	Government Polytechnic, Sirsa (Hissar) (S.G.)—1962	Civil	45	35	13	
		Mech.	90	69	40	
		Elec.	45	35	43	
			180	139	96	
13	Chhotu Ram Polytechnic, Rohtak (P)—1956	Civil	60	22	31	
		Mech.	30	11	..	
		Elec.	30	12	..	
			120	45	31	
14	Vaish Technical Institute, Rohtak (P)—1957	Civil	60	40	15	
15	YMCA Institute of Engineering, Faridabad (P)—1969	Mech.	45	45	..	Sandwich courses of 4 years.
		Elec.	30	30	..	
			75	75	..	
Punjab						
16	Jagat Ram Govt. Polytechni, Hoshiarpur (S.G.)—1933	Civil	60	20	9	
		Mech.	60	28	42	
		Elec.	60	28	58	
			180	76	109	
17	Government Polytechnic, Guru Tegh Bahadur Garh (S.G.)—1963	Civil	60	9	18	
		Mech.	60	13	20	
		Elec.	50	13	60	
			180	35	98	

1	2	3	4	5	6	7
18	Government Polytechnic, Batala (S.G.)—1964	Civil	30	13	15	
		Mech.	45	..	27	
		Elec.	45	27	37	
			120	40	79	
19	Government Polytechnic, Amritsar (S.G.)—1965	Civil	60	19	..	
		Mech.	60	29	42	
		Elec.	60	29	41	
			180	77	83	
20	Panjab Institute of Textile Technology, Amritsar (S.G.)—1920	Tex.Tech	30	32	19	
21	Govt. Tanning Institute, Jullundur City (S.G.)—1934	Leather Tech.	10	5	2	
		Foot-wear Tech.	15	8	8	
			25	13	10	
		(a) Diploma (Full-time)				
22	Thapar Polytechnic, Patiala (P)—1956	Civil	60	33	19	
		Mech.	60	34	53	
		Elec.	60	34	59	
			180	101	131	
		(b) Diploma (Part-time)				
		Elec.	60	..	12	
		(a) Diploma (Full- time)				
23	Guru Nanak Engg. College, Ludhiana (P)—1952	Civil	30	19	11	
		Mech.	60	21	51	
		Elec.	60	39	56	
		Auto. (Post Diploma)	30	13	17	
		Mech. Engg. (Sandwich course)	30	..	..	
			210	92	135	
		(b) *Diploma (Part-time)*				
		Mech.	60	..	22	
24	Mehr Chand Polytechnic, Jullundur (P)—1954	Civil	60	25	48	
		Mech.	60	44	55	
		Elec.	60	61	59	
			180	130	162	
25	Ramgarhia Polytechnic, Phagwara (P)—1950	Civil	60	19	48	
		Mech.	60	32	54	
		Elec.	60	53	56	
			180	104	158	
Rajasthan						
26	Jodhpur Polytechnic, Jodhpur (S.G.)—1958	Civil	120	30	34	
		Mech.	90	45	48	
		Elec.	90	30	32	
		Electronics	..	3	..	
			300	108	114	

1	2	3	4	5	6	7
27	Udaipur Polytechnic, Udaipur (S.G.)—1957	Mech.	60	26	29	
		Elec.	60	21	24	
		Min.	20	..	5	
			140	47	58	
28	Ajmer Polytechnic, Ajmer (S.G.)—1957	Civil	60	20	16	
		Mech.	90	20	69	
		Elec.	90	31	54	
		Auto	..	8	..	Started from 1969-70
			240	79	139	
29	Alwar Polytechnic, Alwar (S.G.)—1957	Civil	30	30	18	
		Mech.	45	9	39	
		Elec.	45	14	34	
			120	53	91	
30	Government Polytechnic, Kota (S.G.)—1960	Civil	60	16	13	
		Mech.	90	38	19	
		Elec.	90	32	17	
			240	86	49	
31	Bikaner Polytechnic, Bikaner (S.G.)—1962	Civil	30	31	13	
		Mech.	45	36	18	
		Elec.	45	28	16	
			120	95	47	
	Uttar Pradesh					
32	Government Polytechnic, Gorakhpur (S.G.)—1909	Civil	90	82	47	
		Mech.	105	105	67	
		Elec.	105	114	71	
			300	301	185	
33	Government Polytechnic, Lucknow (S.G.)—1892	Civil	90	9	3	
		Mech.	105	81	43	
		Elec.	105	85	40	
		Auto. (Post Diploma)	10	10	..	Started in 1969-70.
			310	185	86	
34	Seth Ganga Sagar Jatia Government Polytechnic, Khurja. (S.G.)—1960	Civil	60	34	31	
		Mech.	60	49	38	
		Elec.	60	49	40	
			180	132	109	
35	Government Polytechnic, Bareilly (S.G.)—1958	Civil	60	58	32	
		Mech.	90	66	55	
		Elec.	90	66	60	
			240	190	147	
36	Government Polytechnic, Jhansi (S.G.)—1960	Civil	60	30	38	
		Mech.	90	43	58	
		Elec.	90	55	49	
			240	128	146	

1	2	3	4	5	6	7
	(a) Diploma (Full-time)					
37	Government Polytechnic, Kanpur . . . . (S.G.)—1962	Civil	60	84	25	
		Mech.	120	119	90	
		Elec.	120	127	77	
			300	330	192	
	(b) Diploma (Part-time)					
		Civil	20	..	6	1st Year courses have been suspended by orders of U. P. Govt.
		Mech.	40	..	33	
		Elec.	40	..	11	
			100	..	50	
38	Government Polytechnic, Azamgarh . . . . (S.G.)—1963	Civil	30	11	5	
		Mech.	75	43	25	
		Elec.	75	49	28	
			180	103	58	
39	Government Polytechnic, Faizabad . . . . (S.G.)—1963	Civil	30	..	11	
		Mech.	75	36	40	
		Elec.	75	41	30	
			180	77	81	
40	Government Polytechnic, Mirzapur . . . (S.G.)—1964	Civil	60	26	4	
		Mech.	90	77	39	
		Elec.	90	66	23	
			240	169	66	
41	Government Polytechnic, Moradabad . . (S.G.)—1964	Civil	60	31	28	
		Mech.	90	64	51	
		Elec.	90	59	44	
			240	154	123	
42	Government Polytechnic, Gonda . . . . (S.G.)—1965	Civil	30	11	8	
		Mech.	45	32	25	
		Elec.	45	30	15	
			120	73	48	
43	Government Polytechnic, Basti . . . . . (S.G.)—1965.	Civil	30	3	5	
		Mech.	45	25	16	
		Elec.	45	28	15	
			120	56	36	
44	Government Central Textile Institute, Kanpur . (S.G.)—1914	Tex. Tech.	20	21	17	
		Tex. Chem.	10	11	4	
			30	32	21	
	(a) Diploma (Full-time)					
45	Northern Regional School of Printing Technology . Allahabad. (S.G.)—1957	Printing Tec.	60	59	39	
	(b) Diploma (Part-time)					
		Printing Tech.	20	19	..	Started in 1968-1969.

1	2	3	4	5	6	7
46	Government Polytechnic, Srinagar (Dist. Garwal) (S.G.)—1968	Civil	10	4	..	Started in 1968-1969
		Mech.	25	10	..	
		Elec.	25	11	..	
			60	25	..	
47	G. O. B. Pant Polytechnic, Aryanagar Settlement Lucknow (S.G.)—1965	Civil	30	31	12	
		Mech.	45	55	4	
		Elec.	45	55	12	
			120	141	29	
48	Government Leather Institute, Kanpur (S.G.)—1916	Leather Tech.	10	11	9	
		Footwear Tech.	20	21	11	
			30	32	20	
49	Government Leather Institute, Agra (S.G.)—1963	Leather Tech.	10	5	7	
		Footwear Tech.	20	7	7	
			30	12	14	
50	Institute of Paper Technology, Saharanpur (C.S.G.)—1965	Paper & Pulp Tech.	30	28	29	
51	University Polytechnic, Muslim University, Aligarh (U)—1937	Civil	120	89	96	
		Mech	90	70	64	
		Elec.	90	70	57	
			300	229	217	
52	M. G. Polytechnic, Hathras (P)—1955	Civil	60	30	10	
		Mech.	60	45	45	
		Elec.	60	45	52	
		Ref. & Air Conditioning Post (Diploma)	10	9*	..	*Started in 1969.
			190	129	107	
53	PMV Polytechnic, Mathura (P)—1909	Civil	60	50	33	
		Mech.	60	55	48	
		Elec.	60	60	34	
			180	165	115	
54	Technical College Dayal Bagh, Agra (P)—1930	Mech.	60	49	49	
		Elec.	60	60	33	
		Auto.	30	30	23	
		Auto (Post Diploma)	30	16	13	
			180	155	118	
55	Lucknow Polytechnic, Lucknow (P) 1922	Civil	60	12	23	
		Mech.	90	55	41	
		Elec.	90	60	36	
			240	127	100	

1	2	3	4	5	6	7
		(a) *Diploma (Full-time)*				
56	Hewett Polytechnic, Lucknow (U)—1904	Civil	60	37	33	
		Mech.	120	111	81	
		Elec.	120	97	87	
			300	245	201	
		(b) *Diploma (Part-time)*				
		Civil	30	..	9	Ist year courses have been suspended by the orders of U.P. Govt.
		Mech.	45	..	13	
		Elec.	45	..	13	
			120	..	35	
57	Nainital Polytechnic, Nainital (P)—1957	Civil	60	11	8	
		Mech.	60	37	42	
		Elec.	60	23	32	
			180	71	82	
58	Chandauli Polytechnic, Chandauli (P)—1957	Civil	30	17	17	
		Mech.	45	38	34	
		Elec.	45	41	24	
			120	96	75	
59	Handia Polytechnic, Handia (P)—1957	Civil	30	12	27	
		Mech.	45	32	42	
		Elec.	45	35	22	
			120	79	91	
60	K. L. Polytechnic, Roorkee (P)—1956	Civil	60	66	46	
		Mech.	60	66	71	
		Elec.	90	66	74	
			240	198	191	
61	Gandhi Polytechnic, Muzaffarnagar (P)—1956	Civil	30	26	16	
		Mech.	45	47	36	
		Elec.	45	47	28	
			120	120	80	
62	D. N. Polytechnic, Meerut (P)—1956	Civil	60	39	13	
		Mech.	60	44	26	
		Elec.	60	55	23	
			180	138	62	
63	D. N. Polytechnic, Baraut (P)—1956	Civil	30	6	12	
		Mech.	45	19	92	
		Elec.	15	16	30	
			120	41	71	
64	Allahabad Polytechnic, Allahabad (P) —1956	Civil	60	35	35	
		Mech.	120	128	79	
		Elec.	120	141	64	
		Industrial Electronics (Post Dip.)	10	10	..	Courses started in 1969.
			310	314	178	

1	2	3	4	5	6	7
65	Town Polytechnic, Ballia] (P) —1956	Civil	30	16	29	
		Mech.	15	16	7	
		Elec.	15	17	16	
			60	49	52	
66	M. P. Polytechnic, Gorakhpur (P)—1958	Civil	30	38	25	
		Mech.	45	51	28	
		Elec.	45	51	25	
			120	140	78	
	EASTERN REGION					
	Assam					
	(a) Diploma (Full-time)					
67	Assam Engineering Institute, Gauhati-3 (S.G.)—1948]	Civil	105	40	60	
		Mech.	30	15	21	
		Elec.	30	8	1	
		Chemical Operators	15	30	8	
			180	93	90	
	(b) Diploma (&Part-time)					
		Civil	40	..	..	
		Mech.	30	..	..	
		Elec.	30	..	..	
			100	..	..	
68	Shillong Polytechnic, Shillong-8 (S.G.)—1965	Civil	60	—4	..	
69	Dibrugarh Polytechnic, Dibrugarh (S.G.)—1965	Civil	60	17	13	
70	H.R.H. the Prince of Wales Institute of Engineering & Technology, Jorhat (S.G.)—1927	Civil	120	80*	55	*Estimated
		Mech.	30	20*	22	
		Elec.	30	17*	14	
			180	117	91	
71	Nowgong Polytechnic, Nowgong (S.G.)—1961	Civil	30	4*	15	*Estimated
		Mech.	60	8*	..	
		Elec.	30	2*	—4	
			120	14	19	
72	Silchar Polytechnic, Silchar (Cachar) (S.G.)—1960	Civil	60	11	49	
		Mech.	30	9	17	
		Elec.	30	9	12	
			120	29	78	
	Bihar (a) Diploma (full time)					
73	New Government Polytechnic, Patna—13 (S.G.)—1955	Civil	60	60	30	
		Mech.	30	30	18	
		Elec.	30	30	34	
			120	120	82	

1	2	3	4	5	6	7
		(b) Diploma (Part-time)				
		Civil	40	..	..	
		Mecl.	30	..	..	
		Elec	30	..	..	
			100	..	..	
74	Government Polytechnic, Gulzarbagh, Patna (S.G.)—1924 (Upgraded from 1963)]	Mech.	45	48	17	
			30	27	11	
		Text. Tech.	30	28	11	
		Ceram. Tech.	15	14	—4	
			120	117	43	
75	Government Polytechnic, Ranchi (S.G.)—1954	Civil	60	71	76	
		Mech.	30	35	40	
		Elec.	30	35	14	
			120	141	130	
76	Government Polytechnic, Muzaffarpur (S.G.)—1947	Civil	60	62	68	
		Mech.	30	32	41	
		Elec.	30	33	38	
			120	127	147	
77	Government Polytechnic, Bhagalpur-3 (S.G.)—1955	Civil	60	60	36	
78	Government Polytechnic, Darbhanga (S.G.)—1959	Civil	60	62	39	
		Mech.	30	30	23	
		Elec.	30	30	29	
			120	122	91	
79	Government Polytechnic, Purnea (S.G.) 1959	Civil	60	60	21	
		Mech.	30	30	11	
		Elec.	30	30	—8	
			120	120	40	
80	Government Polytechnic, Dhanbad (S.G.)—1958	Civil	120	120	84	
		Mech.	90	86	35	
		Elec.	30	30	20	
			240	236	139	
81	Government Polytechnic, Gaya (S.G.)—1950	Civil	60	60	..	
		Mech.	30	30	..	
		Elec.	30	30	..	
			120	120	..	
82	Government Polytechnic, Dumka (S.G.)—1964	Civil	..	..	22	
83	Government Polytechnic, Barauni (S.G. 1964)	Civil	60	59	23	
84	Government Polytechnic, Saharsa (S.G.)—1966	Civil	..	..	33	
85	Mining Institute, Dhanbad, (S.G.)—1958 (Formerly Mining Institute, Jharia)	Min.	20	20	—7	

1	2	3	4	5	6	7
86	Mining Institute, Kodarma (S.G.)—1958	Mining & Min. Survey	20	20	25	
	Manipur					
87	Adimjati Technical Institute, Imphal (P)—1956	Civil	30	30	13	
		Mech.	15	15	..	
		Elec.	15	15	..	
			60	60	13	
	Orissa					
88	Orissa School of Engineering, Cuttack-1 (S.G.)—1923	Civil	120	11	21	
		Mech.	60	36	36	
		Elec.	60	36	61	
			240	83	118	
89	Engineering School, Berhampur (S.G.)—1967	Civil	120	4*	18	*Estimated
		Mech.	60	8*	21	
		Elec.	60	10*	69	
			240	22	108	
90	Jharsaguda Engineering School Jharsaguda (S.G.)—1955	Civil	120	17	—3	
		Mech.	60	—8	21	
		Elec.	60	—8	23	
			240	33	47	
91	State Technological Institute, Rourkela-4 (S.G.)—1963	Mech.	15	23	14	
		Elec.	15	24	6	
		Meta.	15	20	10	
		Chem.	15	20	9	
			60	87	39	
92	School of Engineering, Bhadrak (S.G.)—1958	Civil	..	..	12	
		Mech.	..	..	19	
		Elec.	..	..	30	
			..	..	61	
93	Orissa School of Mining Engineering, Keonjhar (S.G.)—1956	Mining	20	22	2	
	Tpipura					
94	Polytechnic Institute, Narsingarh, P.O., Agartala (S.G.)—1958	Civil	30	2	..	
		Mech.	15	2	..	
		Elec.	51	2	..	
			60	6	..	
	West Bengal					
		(a) Diploma (Full-time)				
95	Asansol Polytechnic, Asansol (S.G.)—1951	Min.	20		15	3-Year course.
		(b) Diploma (Part-time)				
		Mech.	60	66	53	5-Year course.
		Elec.	60	48	28	
			120	114	81	

1	2	3	4	5	6	7
		(c) 2-year Technician Course				
		Mech.	30	..	21	
		Elec.	30	..	6	
			60	..	27	
96	Sudhir Sen Polytechnic, Kanyapur, Asansol (Burdwan) (S.G. SPO)—1965	Mech.	60	35*	42	*Estimated
		Elec.	60	34	8	
			120	69	50	
		(a) Diploma (Full-time)				
97	Acharya Prafulla Chandra Roy Polytechnic, Calcutta-32 (S.G. Sp.)—1952	Civil	90	54	59	
		Mech.	120	122	107	
		Elec.	30	37	31	
			240	213	197	
		(b) Diploma (Part-time)				
		Civil	30	26	20	
		Mech.	60	71	46	
		Elec.	30	32	15	
			120	129	81	
		(a) Diploma (Fulli-tme)				
98	Shri Jnan Chandra Ghosh Polytechnic, Calcutta-23 (S.G. Sp.)—1959	Civil	60	28	70	
		Mech.	90	83	149	
		Elec.	30	33	41	
			180	144	260	
		(b) Diploma (Part-time)				
		Civil	20	16	27	
		Mech.	20	24	25	
		Elec.	20	23	13	
			60	63	65	
99	Ramakrishna Mission Shilpamandira, Belurmath Howrah (S.G. Sp.)—1954	Civil	75	41	50	
		Mech.	65	80	83	
		Elec.	40	43	27	
			180	164	160	
100	The Calcutta Technical School, Calcutta (P)—1925	Civil	30	19	..	5-Year course
		Mech. Elec.	90	57	72	5-Year course
		Mech. Elec.	80	96	250	4-Year course
			200	172	322	
101	Ramakrishna Mission Shilpapitha, Belghoria, Calcutta-56, 24-Parganas (S.G. Sp.)—1958	Civil	90	4	46	
		Mech.	120	40	78	
		Elec.	30	13	35	
			240	57	159	

1	2	3	4	5	6	7
102	Birla Institute of Technology, Calcutta-50 1960	Mech. (Sandwich course)	50	13	23	4-Year course
		Mech. (Part-time)	20	18	13	5-Year course
		Elec. (Part-time)	20	16	6	5-Year course
			90	47	41	
		Technical Course				
		Mech.	30	..	7	
		Elec.	30	..	5	
			60	..	12	
103	Don Bosco Polytechnic, Cossipore, Calcutta-2 (S.G. Sp.)—1963	Civil.	60	4	14	
		Mech.	90	45	67	
		Elec.	30	33	30	
			180	82	11	
		(*a*) *Diploma* (*Full-time*)				
104	Central Calcutta Polytechnic, Calcutta (S.G. Sp.)—1963	Mech.	60	49	46	
		Elec.	30	27	23	
		Radio Comn.	30	32	19	
			120	108	88	
		(*b*) *Diploma* (*Part-time*)				
		Mech.	40	42	25	
		Elec.	20	18	1	
			60	60	26	
105	Hoogly Institute of Technology, Hoogly (S.G. Sp.)—1957	Civil	90	6	92	
		Mech.	120	37	126	
		Elec.	30	20	38	
		Auto (Post Dip.)	30	3	17	
			270	66	273	
106	Polytechnic, Darjeeling Distt. Nimalodge P. O. Kurseong Darjeeling (S.G. Sp.)—1964	Civil	30	5	11	
107	Acharya Jagdish Chandra Polytechnic, Debalaya (S.G. Sp.)—1963	Civil	30	2	70	
		Mech.	67	13	51	
		Elec.	30	1	95	
			120	16	216	
108	M.B.C. Institute of Engineering and Technology, Burdwan (S.G. p.)—1949	Civil	60	20	16	
		Mech.	90	25	86	
		Elec.	30	21	16	
			180	66	118	

1	2	3	4	5	6	7
109	BPC Institute of Technology Krishnagar (S.G. Sp.)—1956	Civil Mech. Elec.	90 120 30	15 24 5	41 101 14	
			240	44	156	
110	Murshidabad Institute of Technology Cassimbazar, Berhampor (S.G. Sp.)—1957	Civil Mech. Elec.	30 60 30	1 10 7	35 94 15	
			120	18	144	
111	Malda Polytechnic, Malda (S.G. Sp.)-1962	Civil. Mech. Elec.	30 15 15	12	56 40 29	
			60	12	125	
112	Sree Ramakrishna Silpa Vidyapith, Suri (S.G. Sp.)—1953	Civil Mech. Elec.	60 90 30	6 9 3	33 85 21	
			180	18	139	
113	K. G. Engineering Institute, Vishnupur (S.G. Sp.)—1949	Civil Mech. Elec.	60 90 30	1 38 16	48 122 37	
			180	55	207	
114	Purulia Polytechnic, Purulia (S.G. Sp.)—1957	Civil Mech. Elec.	60 30 30	24 15 12	57 78 29	
			120	51	164	
115	Ishwar Chandra Vidyasagar polytechnic, Jhargram Midnapur (S.G. Sp.)—1957	Civil Mech. Elec.	30 90 60	8 24 16	15 124 19	
			180	48	158	
116	Jalpaiguri Polytechnic Institute, Jalpaiguri (S.G. Sp.)—1959	Civil Mech. Elec.	60 90 30	4 18 6	13 82 20	
			180	28	145	
117	Cooch Behar Polytechnic (CO Jenkin School)," Cooch Behar. (S.G. Sp.)—1964	Civil Mech. Elec.	20 20 20	6* 5 6	32 15 16	*Estimated
			60	17	63	
	(a) Diploma (Fulls time)					
118	The School of Printing Technology, Calcutta-32 (C.S.G.)—1956	Printing	60	64	29	
	(b) Diploma (Part-time)					
		Printing	20	26	14	

1	2	3	4	5	6	7
119	College of Textile Technology, Berhampur (S.G.)—1958	Tex. Tech	20	20	19	
120	Institute of Mining, Ranigange (S.G.)—1905	Mining	48	36	9	
121	College of Leather Technology, Calcutta-15 (S.G.)—1955	Leather Tech.	30	26	..	
	WESTERN REGION					
	Goa					
122	Government Polytechnic Panjim (Goa) (S.G.)—1963	Civil	40	21	..	
		Mech.	40	21	19	
		Elec.	40	21	2	
			120	63	21	
	Gujarat					
123	Dr. S. & S. S. Gandhi College of Engineering and Technology, Surat. (S.G.)—1955	Civil	60	16	13	
		Mech.	90	87	61	
		Elec.	90	81	61	
		Auto.	20	29	13	
		Meta.	30	7	22	
			290	220	170	
124	Government Polytechnic, Ahmedabad (S.G.)—1957	Civil	120	46	46	
		Mech.	120	120	93	
		Elec.	60	60	69	
			300	226	198	
125	Government Polytechnic, Dohad (S.G.)—1959	Civil	60	5	5	
		Mech.	60	31	58	
		Elec.	60	25	47	
			180	61	110	
126	Government Polytechnic, Porbander (S.G.)—1960	Civil	60	4	..	
		Mech	30	20	10	
		Elec.	30	4	9	
			120	28	19	
127	K. D. Polytechnic, Patan (S.G.)—1960	Civil	60	20	..	
		Mech.	60	20	..	
		Elec.	60	10	..	
			180	50	..	
128	Shri Krishan Lal Jhaveri Polytechnic, Broach (S.G.)—1961	Civil	60	2	13	
		Mech.	60	19	47	
		Elec.	60	15	32	
			180	36	92	
129	Sir Bhavsinhji Polytechnic, Bhavnagar (S.G.)—1949	Civil	60	6	23	
		Mech.	120	101	85	
		Elec.	120	47	83	
		Auto.	30	29	25	
		Text. Tech.	30	16	17	
			360	199	233	

1	2	3	4	5	6	7
130	Lukhdhirji Engineering College, Morvi (S.G.)—1940	Civil	60	9	12	
		Mech	30	8	24	
		Elec.	30	8	25	
			120	25	61	
131	Government Polytechnic, Rajkot (S.G.)—1964	Civil	60	7	4	
		Mech.	60	10	31	
		Elec.	60	42	35	
			180	54	70	
132	Government Polytechnic, Bulsar (S. G.)—1965	Civil	10	1	7	
		Mech	30	22	13	
		Elec	30	9	10	
		Chem.	30	30	..	
		Const & Structure	20	1	..	
			120	63	30	
133	R.C. Technical Institute, Ahmadabad (S.G.)—1910	Text. Tech.	30	10	15	
		Text. Chem.	15	12	16	
			45	22	35	
134	A. V. Parekh Technical Institute, Rajkot (SG.)—1948	Electronic and Radio	20	30	19	
		Sound	20	21	11	
			40	51	30	
135	M. S. University Polytechnic, Baroda (U)—1957	Civil	120	120	34	
		Mech.	150	116	115	
		Elec.	90	78	104	
			360	314	253	
136	Faculty of Technology and Engineering, M.S. University, Baroda (U)—1949	Text. Tech.	30	34	28	
		Text. Chem.	30	22	29	
		Refn. & Air Conditioding	30	..	3	
			90	56	60	
137	Bhailbhai and Bhikhabhai Polytechnic, Vallabhaividya Nagar, Distt. Kaira (P)—1958	Civil	60	60	22	
		Mech.	90	90	81	
		Elec.	90	90	56	
			240	240	159	
138	T. F. Gandhidham Polytechnic, Adipur (Kutch) (P)—1955	Civil	40	11	32	
		Mech.	40	33	..	
		Elec.	40	16	..	
			120	60	32	
139	L. M. College of Pharmacy, Ahmedabad (P)—1947	Pharm.	160	146	124	

1	2	3	4	5	6	7
	Madhya Pradesh					
140	Government Polytechnic (Central Technical Institute), Gwalior (SG.)—1965	Civil	50	23	13	
		Mech.	50	23	4	
		Elec.	50	23	7	
		Text. Tech.	10	19	9	
			160	88	33	
		Post Diploma				
		Structural Engineering	15	..	..	
141	G. T. Government Polytechnic, Jaora (S.G.)—1955	Civil	60	11	25	
		Mech.	30	10	17	
		Elec.	30	9	18	
			120	30	60	
142	Government Polytechnic, Jabalpur (S.G.)—1955	Civil	60	56	10	
		Mech.	60	59	7	
		Elec.	60	59	4	
			180	17	21	
143	Government Polytechnic, Khandwa (S.G.)—1960	Civil	60	20	8	
		Mech.	30	10	5	
		Elec.	30	11	3	
			120	41	16	
144	Government Polytechnic, Nowgong (S.G.)—1962	Civil	40	40	39	
		Mech.	40	27	6	
		Elec.	40	27	6	
			120	94	51	
145	Kirodimal Government Polytechnic, Raigarh (S.G.)—1955	Civil	40	11	13	
		Mech.	40	11	6	
		Elec.	40	10	5	
			120	32	24	
146	Government Polytechnic, Ujjain (S.G.)—1955	Civil	40	11	8	
		Mech	40	11	6	
		Elec.	40	11	6	
		Auto. Engg. (Post Dip.)	12	12	17	
			132	45	37	
147	S. V. Government Polytechnic, Bhopal (S.G.)—1953	Civil	75	40	23	
		Mech.	75	40	29	
		Elec.	70	25	10	
		Pharm.	30	13	12	
			250	118	74	
148	Government Polytechnic, Durg. (S.G.)—1962	Civil	40	16	3	
		Mech.	40	25	4	
		Elec.	40	24	2	
		Meta.	30	11	3	
			150	76	12	
149	Polytechnic, Seoni (P)—1964	Civil	60	11	12	
		Mech.	30	..	..	
		Elec.	30	..	..	
			120	11	12	

1	2	3	4	5	6	7
150	Polytechnic Institute, Ashok Nagar (P)—1964	Civil Mech. Elec.	60 30 30	11	12	
			120	11	12	
151	Government Polytechnic, Chindwara (S.G.)—1958	Civil Mech. Elec.	20 20 20	3 7 9	*	*No Examination held for final diploma
			60	19	..	
152	Government Mining Polytechnic, Shahdol (S.G.)—1960	Mech. Elec. Min.	30 30 10	13 10 10	7 4 6	
			70	33	17	
153	Samrat Ashok Technological Institute, (Polytechnic Section) Vidisha (P)—1956	Civil Mech. Elec.	23 23 4	7 6 6	9 3 1	
			60	19	13	
		(a) *Diploma (Full-time)*				
154	Shri Vaishnav Polytechnic, Indore (P)—1962	Civil Mech. Elec.	80 80 40	26 26 10	11 16 9	
			200	62	36	
		(b) *Diploma (Part-time)*				
		Civil Mech. Elec.	20 50 50	.. .. ..	.. 5 6	
			120	..	11	
155	Polytechnic, Balaghat (P)—1962	Civil Mech. Elec.	20 20 20	6 6 5	13 6 1	
			60	17	20	
156	Dhamtari Polytechnic, Dhamtari (Rudri) (P)—1962	Civil Mech. Elec.	30 15 15	14 12 8	6 3 3	
			60	35	12	
157	Polytechnic, Harda (P)—1962	Civil Mech. Elec.	20 20 20	29 31 25	3 8 ..	
			60	85	11	
158	Polytechnic Institute, Khurai Distt, Sagar (P)—1962	Civil Mech. Elec.	30 30 30	29 12 3	17 3 ..	
			90	44	20	

1	2	3	4	5	6	7
159	Polytechnic, Damoh (G)—1965	Civil	20	18	2[illegible]	
		Mech.	20	19	[illegible]	
		Elec.	20	11	4	
			60	48	31	
160	J. N. Polytechnic, Sanawd West Nimar (P)—1965	Civil	20	7	7	
		Mech.	20	9	3	
		Elec.	20	7	2	
			60	23	12	
	Maharashtra					
161	Government Polytechnic, Aurangabad S.G.)—1965	Civil	60	33	6	
		Mech.	60	33	17	
		Elec.	60	33	16	
			180	99	39	
162	Government Polytechnic, Poona (S.G.)—1957	Civil	120	122	33	
		Mech.	100	102	80	
		Elec.	60	62	12	
		Met.	30	32	12	
		Elec. Comn.	20	22	..	
			330	340	137	
163	Government Polytechnic, Amravati (S.G.)—1955	Civil	60	34	4	
		Mech.	60	38	23	
		Elec.	60	38	18	
		Pharm.	60	70	11	
			240	180	56	
164	Government Polytechnic, Bombay (S.G.)—1960	Civil	40	123	32	
		Mech	40	..	..	
		Elec.	40	..	..	
			120	123	32	
165	Government Polytechnic, Dhulia (S.G.)—1954	Civil	60	21	15	
		Mech.	60	21	21	
		Elec.	60	20	9	
			180	62	45	
166	Government Polytechnic, Jalgaon (S.G.)—1960	Civil	60	60	22	
		Mech.	60	60	22	
		Elec.	60	60	22	
		Phar	60	60	20	
			240	240	86	
167	Government Polytechnic, Karad (S.G.)—1957	Civil	60	16	3[illegible]	
		Mech.	60	16	19	
		Elec.	60	15	22	
		Pharm	60	43	15	
			240	90	59	
168	Government Polytechnic, Kolhapur (S.G.)—1961	Civil	60	21	7	
		Mech.	60	21	12	
		Elec.	60	20	13	
			180	62	32	

1	2	3	4	5	6	7
169	Government Polytechnic, Ratnagiri (S.G.)—1961	Civil	60	8	7	
		Mech.	60	7	19	
		Elec.	60	6	..	
			180	21	26	
170	Government Polytechnic, Khamgaon (S.G.)—1961	Civil	60	25	10	
		Mech.	60	24	10	
		Elec.	60	24	9	
			180	73	29	
171	P. L. Government Polytechnic, Latur (S.G.)—1955	Civil	60	19	12	
		Mech.	60	18	4	
			120	37	16	
172	Government Polytechnic, Nagpur (S.G.)—1914	Civil	70	58	20	
		Mech.	40	34	15	
		Elec..	40	34	13	
		Meta.	30	26	6	
		Min.	20	18	10	
		Auto. (Post Dip.)	15	13	..	
			215	183	64	
173	Government Polytechnic, Sholapur (S.G.)—1956	Civil	60	39	12	
		Mech.	60	38	30	
		Elec.	60	38	15	
			180	115	57	
174	Government Polytechnic, Nanded (S.G.)—1964	Civil	60	23	11	
		Mech.	30	..	..	
		Elec.	30	..	..	
			120	23	11	
175	Government Polytechnic, Yeotmal (S.G.)—1964	Civil	120	41	11	
		(a) Diploma (Full-time)				
176	School of Printing Technology, Bombay (S.G.)—1964	Letter Press	35	37	26	3-Year courses
		Lithography	15	17	22	
			50	54	48	
		(b) Diploma (Part-time)				
		Letter Press	35	39	14	4-Year courses
		Lithography	15	18	17	
			50	57	31	
177	Government Institute of Leather Technology, Bandra East, Bombay. (S.G.)—1939	Leather Tech.	10	12	5	
178	K. J. Sonaiya Polytechnic, Bombay (P)—1963	Civil	60	63	10	
		Mech.	60	63	21	
		Elec.	60	63	10	
			180	189	[illegible]	

1	2	3	4	5	6	7
179	Shri Bhagubhai Mafatlal Polytechnic, Ville Parle, Bombay. (P)—1963	Civil	60	68	15	
		Mech.	60	68	50	
		Elec.	60	67	28	
			180	203	93	
180	Sir Cusrow Wadia Institute of Technology, Poona (P)—1938	Civil	60	61	19	
		Mech.	60	61	20	
		Elec.	60	61	41	
		Electronics & Radio	30	30	35	
			210	213	115	
181	M. H. Saboo Siddik Polytechnic, Bombay . . (P)—1936	Civil . .	40	42	6	
		Mech. . .	40	41	15	
		Elec. . .	40	41	19	
			120	124	20	
182	Victoria Jubilee Technical Institute, Bombay . . (P)—1887	Civil . .	60	72	19	
		Mech. . .	60	61	49	
		Elec. . .	60	61	39	
		Text. Tech. .	40	10	20	
		Text. Chem.	40	10	35	
			260	204	161	
183	Walchand College of Engineering, Sangli. . . (P)—1947	Civil. . .	60	25	13	
		Mech. . .	60	24	26	
		Elec. . .	60	24	13	
			180	73	52	
184	St. Xaviers Technical Institute, Bombay . . . (P)—1937	Electronics & Radio Engg. . .	60	72	66	
		Sound. .	40	25	4	
			100	79	70	

SOUTHERN REGION

Andhra Pradesh

(a) *Diploma (Full-time)* 3-*Year courses*

1	2	3	4	5	6	7
185	Government Polytechnic, Hyderabad . . . (S.G.)—1922	Civil . .	..	38	..	Due to Telangana agitation no out-turn figures.
		Mech. . .	..	40	..	
		Elec. . .	..	50	..	
		Elec. Comn.	30	41	..	
			30	169	..	

(b) *Diploma (Full-time)* 2-*Year courses*

1	2	3	4	5	6	7
		Civil . .	60	17	..	Due to Telangana agitation no out-turn figures.
		Mech. . .	75	40	..	
		Elec. . .	75	33	..	
		Auto. . .	30	40	..	
		Pharm. .	30	20	..	
			270	150	..	

1	2	3	4	5	6	7
		(c) Diploma (Part-time) 4-Year courses.				
		Mech. . .	40	41	. .	Due to Telangana agitation no out-turn figures.
		Elec. . .	40	46	. .	
			80	87	. .	
		(a) Diploma (Full-time) 3-Year courses				
186	Andhra Polytechnic, Kakinada (S. G.)—1946	Elec. Comn.	30	30	16	
		(b) Diploma (Full-time) 2-Year courses				
		Civil . .	40	4	26	
		Mech. . .	70	74	43	
		Elec. . .	70	12	23	
		Auto. . . .	30	31	24	
			210	121	116	
		(c) Diploma (Part-time) 4-Year Course				
		Mech. . .	20	. .	. .	Information not supplied.
		Elec. . .	20	. .	. .	
			40	. .	. .	
		(a) Diploma (Full-time)				
187	Government Polytechnic, Vijayawada (S.G.)—1946	Civil. . .	60	37	24	
		Mech. . .	60	69	40	
		Elec. . .	60	70	29	
		Meta. . .	. .	21	12	
			180	197	105	
		(b) Diploma (Part-time)				
		Civil. . .	20	. .	. .	
		Mech. . .	20	13	3	
		Elec. . .	20	20	6	
			60	33	9	
188	Government Polytechnic, Warangal (S. G.)—1955	Civil. . .	60	17	. .	No out-turn due to Telangana agitation
		Mech. . .	60	38	. .	
		Elec. . .	60	29	. .	
			180	84	. .	
189	Government Polytechnic, Vishakapatnam (S. G.)—1956	Civil . .	60	20	18	
		Mech. . .	60	50	36	
		Elec. . .	60	50	30	3-Year courses
		Meta. . .	30	30	10	
		Sandwich in Mech. .	30	30	10	4-Year courses
		Pharm. .	30	30	19	2-Year courses
			270	210	123	
190	Government Polytechnic, Mahboobnagar (S. G.)—1956	Civil . .	40	2	. .	No out-turn figures due to Telangana agitation.
		Mech. . .	40	12	. .	
		Elec. . .	40	13	. .	
			120	28	. .	

1	2	3	4	5	6	7
191	S. V. Government Polytechnic, Tirupati. (S. G.)—1957	Civil	60	1	12	
		Mech.	60	17	5	
		Elec.	60	32	36	
		Pharm.	30	30	18	
			210	80	71	
192	Government Polytechnic, Proddatur (S. G.)—1959	Civil	40	1	29	
		Mech.	40	29	25	
		Elec.	40	[illegible]	18	
			120	35	72	
193	Government Polytechnic, Nizamabad. (S. G.)—1959	Civil.	40	1	..	No out-turn figures due to Telangana agitation.
		Mech.	40	6	..	
		Elec.	40	12		
			120	19	..	
194	Government Polytechnic, Anantapur (S. G.)—1960	Civil.	40	3	7	
		Mech.	40	20	5	
		Elec.	40	8	5	
			120	31	17	
195	M.B.T.S. Government Polytechnic, Guntur. (S. G.)—1960	Civil	40	9	11	
		Mech.	40	36	9	
		Elec.	40	37	17	
		Text. Tech.	30	19	8	
			150	101	45	
196	Government Polytechnic, Nellore—2 (S.G.)—1960	Civil.	40	3	32	
		Mech.	40	38	40	
		Elec.	40	22	25	
			120	63	97	
197	E. S. C. Government Polytechnic, Nandyal (S. G.)—1960	Civil.	40	..	17	
		Mech.	40	18	14	
		Elec.	40	19	5	
			120	37	36	
198	Government Polytechnic, Srikakulam (S. G.)—1961	Civil.	40	1	23	
		Mech.	40	20	14	
		Elec.	40	6	12	
			120	27	49	
199	Government Ceramic Institute, Gudur (S. G.)—1954	Ceram. Tech.	21	5	15	
200	Government Polytechnic (Previously Govt. Mining Institute), Gudur. (S. G.)—1957.	Civil.	40	1	15	
		Mech.	40	18	37	
		Elec.	40	5	7	
			120	24	59	
201	Government Mining Institute, Kothagudem (S. G.)—1957	Min. Engg.	20	6	..	No out-turn figures due to Telangana agitation.

1	2	3	4	5	6	7
202	Jawaharlal Nehru Polytechnic, Hyderabad (P)—1957	Civil.	60	44	..	No out-turn figures due to Telangana agitation.
		Mech.	60	43	..	
		Elec.	60	41	..	
			180	128	..	
203	Shri M. V. M. Polytechnic, Tanuku (P)—1958	Civil.	60	47	45	
		Mech.	60	62	42	
		Elec.	60	77	42	
			180	186	129	
204	Krishnadevaraya Polytechnic, Wanaparthy (P)—1959	Cvil	40	63	..	No out-turn figures due to Telangana agitation. *2—Year course.
		Mech.	40	64	..	
		Elec. Comm.	40	40	..	
		Practice.	40*	34	..	
			160	221	..	
Kerala						
		(a) *Diploma (Full-time)*				
205	Kerala Government Polytechnic, Calicut—5] (S. G.)—1946	Civil.	90	73	14	
		Mech.	75	40	51	
		Elec.	75	40	29	
		Chem.	30	29	24	
			270	182	118	
		(b) *Diploma (Part-time) 4-Year Courses*				
		Civil	..	8	11	
		Mech.	..	5	7	
		Elec.	..	8	6	
			..	21	24	
		(a) *Diploma (Full-time)*				
206	Maharaja's Technological Institute, Trichur (S. G.)—1946	Civil	60	32	8	
		Mech.	60	33	34	
		Elec.	60	33	25	
			180	98	67	
		(b) *Diploma (Part-time) 4-Year course*				
		Civil	20	3	4	
		Mech.	20	13	5	
		Elec.	20	5	5	
			60	21	14	
		(*a*) *Diploma (Full-time)*				
207	Government Polytechnic, Kalamassery (S. G.)—1951	Civil	60	53	21	
		Mech.	90	26	24	
		Elec.	60	53	35	
		Auto.	30	30	19	
		Chem. Operators.	30	20	11	
			270	182	110	

1	2	3	4	5	6	7
		(b) *Diploma (Part-time) 4-Year course.*				
		Civil	20	16	10	
		Mech.	20	16	13	
		Elec.	20	16	5	
			60	48	28	
208	Government Polytechnic, Canannore (S. G.)—1958	Civil	60	30	..	Out-turn figures not supplied.
		Mech.	80	50	..	
		Elec.	40	23	..	
		Text. Tech.	30	30	..	
			210	133	..	
209	Central Polytechnic, Trivandrum-13 (S. G.)—1958	Civil.	60	34	10	
		Mech.	80	55	18	
		Elec.	40	24	12	
			180	113	40	
210	Sree Ram Polytechnic, Valapad (S.G.)—1958	Civil.	60	46	41	
		Mech.	30	25	29	
		Elec.	30	25	31	
			120	96	101	
211	Government Polytechnic, Kottayam. (S. G.)—1960	Civil	60	50	26	
		Mech.	30	23	33	
		Elec.	30	23	18	
			120	96	77	
212	Government Polytechnic, Perinthalmanna (S. G.)—1961	Civil.	60	5	19	
		Mech.	30	23	29	
		Elec.	30	23	15	
			120	96	63	
213	Institute of Textile Technology, Trivandrum (S.G.)—1938	Text. Tech.	30	30	23	
214	Government School of Printing Technology, Shoranur-2 (S. G.)—1967	Letter Press.	30	30	..	
215	Thiagaraja Polytechnic, Alagappanagar (P)—1956	Civil.	60	48	42	
		Mech.	80	64	65	
		Elec.	40	32	38	
			180	144	145	
216	Sree Narayana Polytechnic, Kottiyam, Quilon (P)—1957	Civil.	60	48	21	
		Mech.	80	61	32	
		Elec.	40	35	33	
			180	144	86	
217	NSS Polytechnic, Pandalam (P)—1958	Civil.	60	60	31	
		Mech.	80	48	42	
		Elec.	40	36	27	
			180	144	100	

1	2	3	4	5	6	7
218	Carmel Polytechnic, Alleppey (P)—1958	Civil.	60	48	34	
		Mech.	80	64	60	
		Elec.	40	32	30	
			180	144	124	
219	S. N. Polytechnic, S. N. Nagar Kanhangaud, P. O., Dist. Canannore (P)—1966	*Mech.	..	30	16	*Not approved by Government of India.
		Auto.	30	29	..	
			30	59	16	
220	Seethi Sahib Memorial Polytechnic, Tirur. (P)—1962	Civil	40	25	21	
		Mech.	40	25	40	
		Elec.	40	26	30	
			120	76	91	
Tamil Nadu						
221	Government Polytechnic, Coimbatore (S. G.)—1945	Civil.	60	74	12	
		Mech.	60	75	56	
		Elec.	60	75	40	
			180	224	108	
		(a) *Diploma (Full-time)*				
222	Central Polytechnic, Madras—20 (S. G.)—1946	Civil.	60	60	12	
		Mech.	90	160	150	
		Elec.	90	100	21	
			240	320	183	
		(b) *Diploma (Part-time) 3-Year course.*				
		Civil.	20	40	..	
		Mech.	40	40	4	
		Elec.	40	40	1	
		Sandwich in Mech.	42	42	31	4-Year course
			142	162	36	
		(c) *Post Dipioma (Part-time)*				
		Refr. & Air Coditioning	..	50	32	2-Years course.
		Meta.	..	20	..	
		Tool Design	..	20	..	
		Town and Country Planning.	..	20	18	1-Year course.
			..	110	50	
		(a) *Diploma (Full-time) 3-Year courses.*				
223	Tamil Nadu Polytechnic, Madurai. (S. G.)—1949	Civil	70	67	7	
		Mech.	70	66	64	
		Elec.	70	66	37	
			210	199	108	

1	2	3	4	5	6	7
		(b) *Post-Diploma* 1 1/2 *years course*				
		Auto.	20	15	..	
		(c) *Diploma (Part-time)* 4-*Year courses*				
		Civil	20	19	..	
		Mech.	20	19	..	
		Elec.	20	7	..	
		Sandwich in Mech.	50	..	18	
			180	45	18	
224	Institute of Textile Technology, Madras-20 (S. G.)—1965	Text. Tech.	30	23	9	
225	Government Polytechnic, Nagercoil (S. G.)—1959	Civil.	60	24	21	
		Mech.	60	28	35	
		Elec.	60	24	27	
			110	76	83	
226	Government polytechnic Vellore (S. G.)—1959	Civil	60	27	18	
		Mech.	60	27	42	
		Elec.	60	27	37	
			180	81	97	
227	Government Polytechnic, Thuvakudi Tiruchirapalli (S. G.)—1963	Civil.	40	40	12	
		Mech.	40	40	26	
		Elec.	40	40	20	
			120	120	58	
228	Government Polytechnic, Tuticorin—3. (S. G.)—1962	Civil.	40	10	..	Second year courses were conducted only in 1968-69,.
		Mech.	40	20	..	
		Elec.	40	13	..	
			120	43	..	
229	Institute of Leather Technology, Madras. (S.G.)—1917	Leath. Tech.	15	19	8	
230	Regional School of Printing, Madras. (S. G.)—1955	(a) *Diploma (Full-time)* 3-*Year course.*				
		Letter. Press.	30	26	14	
		Litho.	30	27	9	
			60	53	23	
		(b) *Diploma (Part-time)* 5-*Year course*				
		Letter Press.	35	17	13	
231	Institute of Chemical Technology, Madras. (S. G.)—1963	Chem. Tech.	60	61	41	
232	Muthiah Polytechnic, Annamalainagar (U)—1958	Civil.	40	36	8	
		Mech.	40	37	26	
		Elec.	40	36	19	
			120	109	53	

1	2	3	4	5	6	7
233	P. T. Lee Chengalvaraya Naickers' Technical Institute	Civil . .	60	60	22	
	Vepery, Madras.	Mech. . .	60	70	57	
	(P)—1906	Elec. . .	60	70	35	
			180	200	114	
234	PSG Polytechic, Coimbatore-4.	Mech. . .	45	80	62	
	(P)—1926	Elec. . .	45	80	26	
			90	160	88	
		Post Diploma				
		Prodn. Engg.	..	6	9	
		Industrial Engg.	..	6	5	
			..	12	14	
235	Ramakrishan Mission Technical Institue, Madras. .	Mech. . .	40	40	44	
	(P)—1925	Auto (Post Diploma) .	10	15	11	
			50	55	55	
236	Seshasayee Institute of Technology, Tiruchirapalli. .	Civil. . .	60	65	25	
		Mech. .	60	64	50	
	(P)—1952	Elec. . .	60	64	48	
			180	193	123	
237	Alagappa Polytechnic, Karaikudi-4. . . .	Civil. . .	60	25	5	
		Mech. . .	60	25	23	
	(P)—1955	Elec. . .	60	25	20	
			180	75	48	
238	Annamalai Polytechnic, Chettinad	Civil. . .	60	11	5	
		Mech. . .	60	45	34	
	(P)—1956	Elec. . .	60	43	30	
			180	99	69	
239	Murugappa Chettiar Memorial Polytechnic, Avadi	Civil. . .	60	60	9	
	Madras-54	Mech. . .	60	60	52	
	(P)—1957	Eled. . .	60	60	53	
			180	180	114	
240	Nachimuthu Polytechnic, Pollachi	Civil. . .	60	78	16	
		Mech. . .	60	78	33	
	(P)—1957	Elec. . .	60	77	48	
			180	223	97	
241	Valivalam Desikar Polytechnic, Nagapattinam . .	Civil . .	60	..	5	
		Mech. . .	60	56	46	
	(P)—1958	Elec. . .	60	56	48	
			180	112	99	
242	Virudhunagar Vellaichamy Nadar Polytecnhic, Viru-	Civil . .	60	9	53	
	dhunagar.	Mech. . .	60	15	91	
	(P)—1958	Elec. . .	60	10	72	
			180	34	216	

	2	3	4	5	6	7
	Sankar Institute of Polytechnic, Sankarnagar, Talaiyuthu.	Civil.	60	32	16	
	(P)—1958	Mech.	60	32	43	
		Elec.	60	32	33	
			180	96	92	
	Thiagarajar Polytechnic, Salem—5.	Civil	40	48	16	
	(P)—1958	Mech.	40	48	37	
		Elec.	40	48	35	
		Text. Tech.	40	48	28	
			160	192	116	
	Bhaktavatsalam Polytechnic, Kancheepuram	Civil.	40	25	14	
	(P)—195	Mech.	40	24	27	
		Elec.	40	24	21	
			120	73	62	
246	Rajagopal Polytechnic, Guddiyatham	Civil.	40	15	20	
	(P)—1960	Mech.	40	16	33	
		Elec.	40	15	18	
			120	46	71	
247	Srinivasa Subbaraya Polytechnic, Puttur (Sirkali) Tanjore Dist.	Civil.	60	46	45	
	(P)—1960	Mech.	30	34	38	
		Elec.	30	30	20	
			120	110	103	
248	Coimbatore Institute of Technology Sandwich Polytechnic, Coimbatore.	..	..	..	..	
	(P)—1961	Sandwich in Mech.	60	49	24	4-Year courses.
249	P. A. C. Ramasamy Raja Polytechnic, Rajapalayam	Civil.	40	30	7	
	(P)—1963	Mech.	40	29	36	
		Elec.	40	29	24	
		Text. Tech.	30	33	24	
			150	121	91	
Mysore						
250	S. J. Polytechnic, Bangalore-1.	Civil	65	58	45	
	(S. G.)—1943	Mech.	135	198	156	
		Elec.	65	66	60	
		Radio.	40	33	22	
		Sound	..	22	8	
		Ceramics	..	15	5	
		Printing.	..	20	10	
		Sanitary.	20	20	..	
			325	432	306	
251	Karnataka Polytechnic, Mangalore	Civil	60	22	12	
	(S. G.)—1946	Mech.	40	54	47	
		Elec.	60	54	20	
		Auto.	20	21	14	
			180	151	93	

1	2	3	4	5	6	7
252	Government Polytechnic Bellary	Civil	60	..	16	
	(S. G.)—1948	Mech.	30	31	26	
		Elec.	30	26	46	
		Tailoring	..	12	6	
			120	57	88	
253	Smt. L. V. Polytechnic, Hassan	Civil	60	..	5	
	(S. G.)—1949	Mech.	60	18	19	
		Elec.	60	20	33	
			180	38	57	
254	D.R.R. Polytechnic, Davanagere	Civil	60	9	25	
	(S.G.)—1949	Mech.	60	30	35	
		Elec.	60	27	34	
		Sec. Practice	40	40	..	
			220	106	94	
255	Government Polytechnic, Chintamani	Civil.	40	..	4	
	(S.G.)—1950	Mech.	40	28	18	
		Elec.	40	21	10	
			120	49	32	
256	C. P. C. Polytechnic, Mysore.	Civil.	60	12	19	
	(S. G.)—1954	Mech.	60	30	41	
		Elec.	60	30	42	
		Auto.	40	40	22	
		Sec. Practice.	40	40	..	
			260	152	124	
257	Government Polytechnic, Gulbarga	Civil.	60	..	16	
	(S. G.)—	Mech.	60	18	31	
		Elec.	60	12	11	
			180	30	58	
258	Government Polytechnic, Tumkur	Civil	40	..	9	
	(S. G.)—1958	Mech.	40	34	14	
		Elec.	40	34	19	
			120	68	42	
259	Government Polytechnic, Channapatna	Civil.	40	..	16	
	(S. G.)—1958	Mech.	40	24	21	
		Elec.	40	..	18	
			120	24	55	
260	Government Polytechnic, Karwar	Civil.	40	..	13	
	(S. G.)—1958	Mech.	40	5	19	
		Elec.	40	..	29	
			120	5	61	
261	D. A. G. Government Polytechnic, Chick magalur	Civil	40	1	11	
	(S. G.)—1958	Mech.	40	19	11	
		Elec.	40	6	15	
			120	26	37	

1	2	3	4	5	6	7
262	Government Polytechnic, Belgaum (S.G.)—1958	Civil	40	20	23	
		Mech.	40	30	33	
		Elec.	40	30	36	
		Sec. Practice	40	30	..	
			160	110	92	
263	Government Polytechnic, Bidar (S. G.)—1960	Civil	40	10	4	
		Mech.	40	10	12	
		Elec.	40	10	7	
			120	30	23	
264	Government Polytechnic, Krishnarajapet (S. G.)—1960	Civil	40	..	18	
		Mech.	40	2	16	
		Elec.	40	8	25	
			120	10	59	
265	Government Polytechnic, Kushalnagar, Coorg (S. G.)—1961	Civil	40	..	10	
		Mech.	40	2	23	
		Elec.	40	13	33	
			120	15	71	
266	Government Polytechnic, Raichur (S. G.)—1961	Civil	40	..	6	
		Mech.	40	12	19	
		Elec.	40	..	19	
			120	12	44	
267	Government Polytechnic, Bijapur (S. G.)—1963	Civil	40	..	25	
		Mech.	40	7	14	
		Elec.	40	22	22	
			120	29	61	
268	S. M. J. Technological Institute, Bangalore (S. G.)—1938	Tex. Tech.	40	40	29	
269	School for Mines, Coromandal, Kolar Gold Field (S. G.)—195	Min.	60	20	16	
270	B. V. Bhoomraddi College of Engg. & Technology Hubli (P)—1946	Civil.	60	..	22	
		Mech.	60	17	32	
		Elec.	60	16	39	
			180	33	93	
271	National Institute of Engineering, Mysore (P)—1964	Civil.	60	..	1	
272	S. J. Polytechnic, Bhadravati (P)—1950	Civil.	60	..	..	
		Mech.	60	36	36	
		Elec.	60	33	26	
		Meta.	30	29	21	
			210	98	83	
273	K.H. Kabbur Institute of Engineering, Dharwar (P)—1956	Civil.	60	..	63	
		Mech.	60	..	..	
		Elec.	60	..	..	
			180	..	63	

1	2	3	4	5	6
274	M. E. I. Polytechnic, Bangalore (P)—1958	Civil.	60		5
		Mech.	60	45	28
		Elec.	60	45	31
			180	90	64
275	Acharya Pathaasa Polytechnic, Bangalore (P)—1958	Civil.	40	5	17
		Mech.	40	33	39
		Elec.	40	32	24
			120	70	80
276	B.V.V. Sangha's Polytechnic, Bagalkot (P)—1958	Civil	40	2	14
		Mech.	40	14	18
		Elec.	40	4	20
			120	20	52
Pondicherry					
277	Motilal Nehru Polytechnic, Pondicherry-3 (S. G.)—1963	Civil	60	20	14
		Mech.	40	15	23
		Elec.	40	13	15
			140	48	52

TABLE—II

SUMMARY (STATE-WISE AND SUBJECT-WISE) 1969

Sl. No.	Name of State (Number of Institutions)	Field of Study	Sanctioned Admission Capacity	Actual Admission made	Out-turn
1	2	3	4	5	6
(A)	*Northern Region*				
(i)	Delhi (3)	Civil	150	141	62
		Mech.	330	231	227
		Elec.	210	177	123
		Pharm.	66	66	
		Electronics	60	28	35
		Auto	30	30	16
		Commercial	.	..	..
		Practice	60	60	..
			906	733	463
(ii)	Himachal Pradesh (2)	Civil	90	64	41
		Mech.	105	15	—9
		Elec.	105	45	67
			300	124	117
(iii)	Jammu & Kashmir (2)	Civil	75	11	24
		Mech.	45	10	39
		Elec.	45	10	29
	..	Auto (Post Dip.)	15	15	9
			180	46	101
(iv)	Punjab (10)	Civil	420	157	168
		Mech.	525	201	366
		Elec.	525	284	438
		Text. Tech.	30	32	19
		Leath. Tech.	25	13	10
		Sandwich course in Mech. Engg.	30	..	..
		Auto. (Post Dip.)	30	13	17
			1585	700	1018
(v)	Chandigarh (1)	Civil	75	33	29
		Mech.	90	48	81
		Elec.	45	33	44
			210	114	154
(vi)	Haryana (7)	Civil	420	237	124
		Mech.	465	271	217
		Elec.	330	194	208
		Auto	30	23	19
			1245	725	568
(vii)	Rajasthan (6)	Civil	300	127	94
		Mech.	420	174	222
		Elec.	420	156	177
		Min.	20	..	5
		Electronics	..	3	..
		Auto	..	8	..
			1160	468	498

1	2	3	4	5	6
(viii)	Uttar Pradesh (35)	Civil	1530	898	687
		Mech.	2195	1669	1319
		Elec.	2195	1719	1166
		Auto.	30	30	23
		Text. Tech.	20	21	17
		Tech. Chem.	10	11	4
		Arch. Asstt. ship	25	23	11
		Ref. Air-conditioning	10	9	..
		Leath. Tech.	60	44	34
		Prtg. Tech	80	78	39
		Paper & Pulp Tech.	90	40	54
		Industrial Elec. (Post Dip.)	10	10	..
		Auto (Post Dip.)	40	26	13
			6295	4577	336
[illegible]	*Eastern Region*				
(ix)	Assam (6)	Civil	475	156	192
		Mech.	180	52	60
		Elec.	150	36	31
		Chem.	15	30	8
			820	274	291
(x)	Bihar (14)	Civil	640	614	432
		Mech.	345	321	185
		Elec.	270	274	154
		Min.	40	40	32
		Text. Tech.	30	28	11
		Ceram. Tech.	15	14	—4
			1340	1291	818
(xi)	Manipur (1)	Civil	30	30	13
		Mech.	15	15	..
		Elec.	15	15	..
			60	60	13
(xii)	Orissa (6)	Civil	360	32	54
		Mech.	195	75	111
		Elec.	195	78	189
		Min.	20	22	2
		Meta	15	20	10
		Chem.	15	20	9
			800	247	375
(xiii)	Tripura (1)	Civil	30	2	..
		Mech. -	15	2	..
		Elec.	15	2	..
			60	6	..
(xiv)	West Bengal (27)	Civil	1180	302	835
		Mech.	1765	906	1789
		Elec.	805	470	617
		Radio	30	32	19
		Mech. & Elec. (combined)	370	153	322
		Printing	80	100	43
		Leath. Tech.	30	26	..
		Auto	30	3	17
			4390	2055	3642

1	2	3	4	5	6
(C)	*Western Region*				
(xv)	Goa (1)	Civil	40	21	..
		Mech.	40	21	19
		Elec.	40	21	2
			120	63	21
(xvi)	Gujarat (17)	Civil	830	302	211
		Mech	940	677	618
		Elec.	820	485	521
		Radio	20	30	19
		Auto.	50	58	38
		Meta	30	7	22
		Text Tech	90	80	64
		Text Chem	45	34	45
		Pharm	160	146	124
		Sound	20	21	11
		Chem	30	30	
		Const & Structure	20	1	
		Ref & Air Conditioning	30	..	3
			3085	1871	1676
(xvii)	Madhya Pradesh (21)	Civil	883	389	257
		Mech.	793	357	140
		Elec.	739	293	91
		Min.	10	10	6
		Meta.	30	11	3
		Auto.	12	12	17
		Pharm.	30	13	12
		Text. Tech.	10	19	9
		Fine Arts	25	15	7
			2532	1119	542
(viii)	Maharashtra (24)	Civil	1350	974	297
		Mech.	1150	730	453
		Elec.	1050	668	298
		Tele-Comn.	110	124	101
		Min.	20	18	10
		Meta	60	58	18
		Auto.	15	13	..
		Text. Tech.	40	10	20
		Chem.	40	10	35
		Arch.	60	45	..
		Town Planning	20	20	..
		Pharm.	180	173	46
		Leath. Tech.	15	20	7
		Prtg.	100	111	79
		Sound	40	25	4
			4250	2999	1368
(D)	*Southern Region*				
(xix)	Andhra Pradesh (20)	Civil	880	276	259
		Mech.	995	687	352
		Elec.	915	524	226
		Elec. Comn.	30	30	16
		Min.	20	6	-
		Auto.	60	71	24
		Text. Tech.	30	19	8
		Ceram Tech.	21	5	15
		Meta.		21	21
		Pharm.	90	80	37
		Commercial Practice	40	34	.. ..
			3081	1753	949

1	2	3	4	5	6
(xx)	Kerala (16)	Civil	830	616	298
		Mech.	875	596	486
		Elec.	605	426	328
		Tele-Comn.	30	..	11
		Auto.	60	59	35
		Text. Tech.	60	60	23
		Chem. Operat	90	69	54
		Printing	30	30	..
			2560	1856	1235
(xxi)	Tamil Nadu (29)	Civil	1150	841	334
		Mech.	1407	1264	1153
		Elec.	1215	1038	697
		Auto.	30	30	11
		Text. Tech.	108	84	61
		Leath Tech.	15	9	8
		Prtg.	95	70	36
		Chem. Operator	60	61	41
		Prodn. Engg.	..	12	14
		Commercial Practice	55	36	6
		Refrigeration	..	50	32
		Town & Country Planning	..	20	18
		Meta	..	20	..
			4135	3535	2411
(xxii)	Mysore (27)	Civil	1265	159	389
		Mech.	1205	705	714
		Elec.	1155	501	614
		Tele-Comn.	40	33	22
		Min.	20	15	16
		Auto.	20	21	4
		Text. Tech.	40	40	29
		Prtg.	..	20	10
		Sound	..	22	8
		Ceram. Tech.	..	15	5
		Meta.	30	29	21
		Commercial Practice	60	60	..
			3835	1620	1830
(xxiii)	Pondicherry (1)	Civil	60	20	14
		Mech.	40	15	23
		Elec.	40	13	15
			140	48	52

Region	No. of Institutions	Sanctioned Admission Capacity	Actual Admissions made	Out-turn
(a) Northern Region	66	11,881	7,487	6,286
(b) Eastern Region	55	7,470	3,933	5,182
(c) Western Region	63	9,987	6,062	3,607
(d) Southern Region	93	13,971	8,812	6,477
GRAND TOTAL	277	43,309	26,294	21,552

ANNEXURE I

RURAL INSTITUTIONS

Sl. No.	Name of the Institution	Field of Study.	Sanctioned admission capacity	Actual Admissions	Out-turn	Remarks
1	2	3	4	5	6	7
1.	Jamia Rural Institute, Jamianagar, New Delhi.	Civil & Rural	30	31	13	3-years course
2.	Vidya Bhavan Rural Institute, Udaipur.	Civil & Rural.	30	37	21	
3.	Balwant Vidyapeeth Rural Institute, Bichpuri (Agra).	Civil & Rural.	30	26	16	
4.	Rural Institute, Pipri (Wardha) (Maharashtra).	Civil & Rural.	30	29	15	
5.	Rural Institute, Amravati (Maharashtra).	Civil & Rural.	60	30	40	
6.	Shri Karmveer Hire Rural Institute, Gargoti, Distt. Kolhapur.	Civil & Rural.	60	12	68	
7.	Shri Ramakrishna Mission Vidyalaya Rural Institute, Coimbatore.	Civil & Rural.	60	19	39	
8.	Rural Institute, Hanumannamatti, Dt. Dharwar (Mysore).	Civil & Rural.	40	15	9	
9.	Rural Institute, Thavanur (Kerala).	Civil & Rural.	30	32	25	
		Total	370	231	246	

ANNEXURE III

GIRLS' POLYTECHNICS

1	2	3	4	5	6	7
	NORTHERN REGION DELHI					
1.	Women's Polytechnic, Kashmere Gate, Delhi-6 (S.G.) 1962.	Electronics	25	21	21	3-year course
		Secretarial Practice	25	30	9	2-year course
		Interior Decoration	25	25	9	3-year course
		Library Science	25	23	21	2-year course
		Medical Laboratory Technology	25	15	10	2-year course
		Commercial Art.	25	29	18	3-year course
		Architectural Asstt. ship.	30	29	21	Do
			180	172	109	
	Chandigarh					
2.	Government Polytechnic for Women, Chandigarh (S.G.) 1962.	Commercial Practice & Stenography.	30	28	10	
		Architectural Asstt. ship.	25	9	20	
		Pharmacy	30	31	12	
		Interior Decoration & Display.	30	11	6	
		Radio Engg. & Electronics	30	10	5	
		Library Science	30	32	21	
			175	121	74	
	Haryana					
3.	Government Polytechnic for Women, Ambala (S.G.) 1968	Library Science	30	30	—	
		Pharmacy	30	27	—	
			60	57	—	
	Uttar Pradesh					
4.	Government Girls' Polytechnic, Lucknow (S.G.)-1963	Electronics	30	20	11	3-year course
		Stenography Secretarial Practice.	30	28	17	2-year course
		Architectural Asstt. ship.	20	7	3	
			80	55	31	

1	2	3	4	5	6	7
5.	Women's Polytechnic, Aligarh Muslim University, Aligarh (U) 1966	Electronics	20	3	6	
		Secretarial Practice	20	9	—	
		Costume Design etc.	20	6	13	
		Architectural Asstt. ship.		—	11	Estimated
			60	18	30	
	EASTERN REGION					
	West Bengal					
6.	Women's Polytechnic, 21, Convent Road, Calcutta- (S.G.) 1963.	Electriacal Communication	30	23	13	3-year course
		Architectural Asstt. ship	30	12	10	
			60	35	23	
	Orissa					
7.	Sk. D. A. V. Polytechnic for Women, Roukela-4 (P) 1968	Tele-Communication	15	6	9	[illegible]-year course
		Library Science	30	20	18	2-year course
		Comm. practice	30	11	4	
			75	37	31	
	Assam					
8.	Girls' Polytechnic, P. O. Silpakhari, Gauhati-3 (S.G.) 1964.	Civil Engg./ Draughtsmanship.	30	15	3	
		Secretarial Practice & Stenography	30	25	1	2-year course
			60	40	4	
	WESTERN REGION					
	Gujarat					
9.	Government Polytechnic for Girls, Ahmedabad-18 (S.G.) 1964.	Secretarial Practice & Stenography	30	32	17	2-year course
		Electronics & Radio Engg.	30	26	8	3-year course
		Architectural D'manship & Asstt. ship.	30	20	1	2-year course
			90	78	26	

1	2	3	4	5	6	7
10.	Government Girls' Polytechnic, Surat (S.G.) 1965.	Secretarial Practice.	30	30	30	2-year course
		Architectural D'manship & Sectt. ship	30	14	14	
		Electronics & Radio Engg.	30	17	17	3-year course
			90	61	61	
	Madhya Pradesh					
11	Women's Polytechnic, Bhopal (S G)-1961	Medical Laboratory Technology	15	14	8	2-year course
		Costume Design & Dress Making	15	15	6	3-year course
		Architectural D'manship	15	5	4	3-year course
		Secretarial Practice & Stenography	15	15	7	3-year course
			60	49	25	
	SOUTHERN REGION					
	Andhra Pradesh					
12.	Kamla Nehru Girls' Polytechnic, Hyderabad (S.G.) 1961	Civil	30	25	—	3-year course
		Elec. Comm Engg.	30	40	—	3-year course
		Catering & Food Technology	30	44	—	3-year course
		Commercial Practice	60	106	—	2-year course
		Pharmacy	60	70	—	
			250	285	—	
13.	Government Polytechnic for Girls, Kakinada, (S.G.) 1961.	Civil	30	14	10	3-year course
		Electrical Commn.	30	33	18	3-year course
		Pharmacy	30	34	—	2-year course
		Commercial Practice.	30	60	32	2-year course
			120	141	60	

1	2	3	4	5	6	7
14.	**Women's Polytechnic, Guntur, (S.G.)-1968**	Comm. Practice	30	44	—	
		Elec. Commn.	30	32	—	
		Costume Design	30	38	—	
			90	114	—	
	Kerala					
15.	**Women's Polytechnic, Trivandrum (S.G.) 1961.**	Commercial Practice	30	50	18	
		Costume Design & Dress Making	30	18	7	
		Civil Engg. D'manship.	30	37	—	
			90	105	25	
16.	**Women's Polytechnic, Trichur-7 (S.G.) 1962**	Secretarial Practice and Stenography	30	50	9	**3-year course**
		Costume Design & Dress Making	30	8	12	**2-year course**
		Electronics	30	40	19	**3-year course**
			99	98	40	
17.	**Women's Polytechnic, Calicut (S.G.) 1963**	Stenography and Secretarial Practice	30	50	14	**3-year Course**
		Costume Design & Dress Making	30	10	7	**3-year course**
		Civil Engg. D'manship.	30	34	19	**1-year course**
			90	94	40	
	Madras					
18.	**Government Polytechnic, for Women, Madras-20 (S.F.) 1962**	Electronics	30	28	14	**3-year course**
		Costume Design & Dress Making	30	20	17	**3-year course**
		Commercial Practice	30	75	39	**2-year course**
		Civil Engg.	30	27	13	**3-year course**
			120	150	83	

1	2	3	4	5	6	7
19.	Government Polytechnic for Women, Madurai-11 (S.G.)-1964.	Civil Engg.	30	20	8	3-year course
		Commercial Practice	30	30	5	2-year course
			60	50	13	
20.	Government Polytechnic, for Women, Coimbatore-18 (S.G.)-1964	Civil Engg.	30	25	6	
		Commercial Practice	30	20	8	2-year course
		Electronics	30	22	—	3-year course
			90	67	14	
	Mysore					
21.	Government Polytechnic, for Women Bangalore (S.G.) 1961.	Secreterial Practice	30	30	12	3-year course
		Costume Design & Dress Making	30	30	13	3-year course
		Library Science	30	30	26	1½ year course
		Civil Engg. D'manship	30	5	5	3-year course
			120	95	57	
22.	Government Polytechnic for Women Hubli (S.G.) 1963	Secreterial Practice	30	5	7	
		Costume Design & Dress making	30	18	1	
		Radio Engg.	30	8	—	
		Civil Engg. D'manship	30	—	3	
			120	31	11	

ANNEXURE III

INSTITUTIONS CONDUCTING COURSES NOT OF A REGULAR PATTERN

1	2	3	4	5	6	7
1	College of Arts and Crafts, Lucknow (S.G.)—1911.	Architectural Assistantship	25	23	11	
2	Government Leather Working School, Bandra East, Bombay (S.G.)—1939.	Leather Technology	5	8	2	
3	Victoria Jubilee Technical Institute, Bombay	Industrial Engg. (Post Dip.)	30	30	12	
4	Sir J. J. College of Architecture, Bombay	Town Planning	20	20	..	3-year course started in 1966.
		Architecture	60	45		7-year course started in 1962.
5	Institute of Commercial Practice, Adyar Madras (S.G.)—1965	Commercial Practice	55	86	6	2-year course
6	S.R. Institute of Secretarial Practice, Bangalore (S.G.))—1968.	Secretarial Practice	60	60		

ANNEXURE IV

INSTITUTIONS CONDUCTING PART-TIME DIPLOMA COURSES IN ENGINEERING AND TECHNOLOGY

	(a) *Civil Mechanica Electrica Engineering*	Admission Capacity
	Name of Institution	
	Chandigarh	
1.	Central Polytechnic, Chandigarh	30
	Punjab	
2.	Guru Nanak Engineering College, Ludhiana	60
3.	Thaper Polytechnic, Patiala	60
	Uttar Pradesh	
4.	Government Polytechnic, Kanpur	100
5.	Hewett Polytechnic, Lucknow	120
	West Bengal	
6	Acharya Prafulla Chandra Ray Polytechnic, Calcutta-32.	120
7.	J. C. Ghosh Polytechnic, Calcutta-23	60
8.	Central Calcutta Polytechnic, Calcutta-14	60
9.	Birla Institute of Technology, Calcutta-50	40
10.	Asansol Polytechnic, Asansol	120
11.	Calcutta Technical School, Calcutta-18	120
	Bihar	
12.	New Government Polytechnic, Patna-13	100
12.	(a) Assam Engineering Institute, Gauhati (Assam)	100
13.	Shri Vaishnav Polytechnic, Indore (M.P.)	120
13.	(a) Government Polytechnic, Gwalior (M.P.)	15
14.	Government Polytechnic, Hyderabad-28 (A.P.)	80
15.	Andhra Polytechnic, Kakinada-2 (A.P.)	40
16.	Government Polytechnic, Vijayawada-8 (A.P.)	60
	Kerala	
17.	Maharaja's Technological Institute, Trichur-1	60
18.	Government Polytechnic, Kalamassery	60
	Madras	
19	Central Polytechnic, Adyar Madras	100
20.	Tamilnad Polytechnic, Madurai	60
	(b) *Printing Technology*	
21.	Northern Regional School of Printing Technology, Allahabad (U.P.)	20
22.	School of Printing Technology, Calcutta (W. Bengal)	20
23.	Government Institute of Printing Technology, Bombay (Maharashtra)	50
24.	Regional School of Printing, Madras	35
		1810

These institutions are also included in the main Survey for Diploma courses of Regular Pattern conducted by them.

APPENDIX V(A)

REPORT OF THE SURVEY OF INDUSTRIES CONDUCTED BY THE CHAIRMAN OF THE SPECIAL COMMITTEE

Origin

One of the terms of reference of the Committee on Reorganisation of Polytechnic Education (CROPE)* constituted by the Government of India is 'to examine the whole system of Polytechnic Education *vis-a-vis* the needs of industry for middle level technicians and to prepare a ten year plan for its re-organisation and development". This necessitates a thorough analysis of the system of Polytechnic Education from all sides. Such an analysis should begin with the knowledge of the requirements of the employers and industry for middle level technicians for suggesting steps to recast the system of polytechnic education. Hence a Survey to collect relevant data from industry and educational institutions has become an integral part of the Committee's work.

At the First Meeting of the CROPE held at New Delhi on 4th April 1970, the Committee decided upon a strategy of action in which the following items have been stressed:

1.1. A sample survey of industry should be carried out with a view to find out the types of jobs where technicians are required. This survey should cover a cross section of industry embracing the heavy, medium as well as small scale industrial sectors.

1.2. A thorough analysis should be made regarding the present system of polytechnic education with a view to find out the lacunae and deficiencies at present *vis-a-vis* job requirements.

1.3. To examine how far diversification at the technicians level is possible keeping in view the need for mobility of technicians both horizontally and vertically.

1.4. To examine the fields in which sandwich courses could be successfully started with indications of the structure of the courses, duration etc.

1.5. To examine how best the practical training can be made industry-oriented and the type of training which the students should get and its correlation with teaching.

1.6. To examine the aspect of faculty development, type of training programme to be fixed for training and retraining of teachers, type of industrial training required for teachers in order to keep them up-to-date.

1.7. To examine how to achieve the maximum involvement of industry in the training of technicians and teachers.

With the above objective in mind a Sub-Committee with Dr. Pranlal Patel as its convenor, was constituted to prepare a questionnarie and to undertake a sample survey. A revised questionnarie seeking both statistical and general information in two parts was finalised at the Second Meeting of the CROPE and was circulated by the Chairman himself.

2. Objectives

The objectives of this survey are:

2.1. To get an idea of how the employers feel about the quality of the present day diploma holders of the Polytechnics.

2.2. To obtain suggestions from the industrialists regarding the suitability of the following systems in polytechnic education.

- (a) specialisation with sandwich training.
- (b) specialisation without sandwiching.
- (c) sandwiching without specialisation.
- (d) neither sandwiching nor specialisation.
- (e) additional post academic training.

2.3. To obtain the employer's interests in the qualities of a diploma holder when the latter is recruited.

2.4. To assess the position of the diploma holders in jobs in relation to the number of graduate engineers and skilled workers.

2.5. To know the involvement of the diploma holder in managerial activities.

2.6. To find out the mobility of the diploma holder in industry both horizontally and vertically.

2.7. To know about the retraining facilities and programmes of technicians.

2.8. To find out the willingness of industry in offering supervised and purposeful training to polytechnic students.

2.9. To find out the co-operation that can be extended by industry in the case of faculty development by training polytechnic teachers in their organisations.

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*CROPE—Committee on Reorganization of Polytechnic Education.

2.10. To estimate the cooperation that can be extended by industry in terms of its willingness to exchange staff with the Polytechnics from time to time.

2.11. To know how far industries are willing to spare their experts to deliver special lectures in their fields.

2.12. To find out the general training facilities available in industry.

3. Approach

The Chairman circulated the questionnaire to the following:

1. Experts in various fields of industry and technical education.
2. Chambers of Commerce and Industry and other Professional Associations.
3. Entrepreneurs and eminent persons.

Several copies of the questionnaire were sent to each Export and Chamber of Commerce, Industry and Professional Association with a request to circulate them in the nearby industries and to furnish an abstract of the replies and findings. Individual entrepreneurs and eminent persons were also contacted and their views and opinions collected. The selection of these units and individuals was such as to make an overall assessment sufficiently representative on all India level.

Apart from the abstract, each expert was also requested to send his views on the points covered by the seven questions of the questionnaire.

Part of the questionnaire calls for statistical information regarding the employment of technical personnel. An analysis of this part reveals the position of a Diploma-holder in relation to the degree-holders and skilled workers.

The pattern of circulation and response to the questionnaire is given below:

	Number addressed	Memoranda & Notes received	Replies to Questionnaire received
1. Experts in various fields of industry and technical education . . .	77 (635 questionnaires sent)	36	186
2. Chambers of Commerce and Industry and Professional Associations .	44	6	..
3. Entrepreneurs and eminent persons .	39	5	..

Chairman also collected information and views from the industrial units in and around Coimbatore through his representatives.

4. Coverage

4.1. Area

The survey covers many industries spread out almost over the entire country by direct contact, as illustrated in figure 4.1. Even though certain states such as Jammu and Kashmir, Orissa etc. are not directly covered to a great extent, the contact made with Central organisations such as Central Water and Power Commission, Indian Council of Agricultural Research, Indian Railways etc. would to some extent reflect the coverage of such areas also.

In figure 4.1, the distribution of replies to the questionnaire received is given. The indicated numbers in each state do not show the size of the individual industries covered. For instance, the three responses from Madhya Pradesh consist of two from large units *viz.* Bhilai Steel plant and Heavy Electricals, Bhopal, and one from an eminent educationist.

The responses from large Associations such as the Institution of Engineers (India), Port Trust of Calcutta Machinery Manufacturing Corporation etc., are sufficient to reflect a reasonable coverage of industries in and around West Bengal.

The large response from the various industries in Maharashtra (39 Nos) is sufficient to yield enough information to reflect the coverage of the neighbouring states too. So the comparatively low response from Gujarat is not very serious.

4.2. Respondents

About 40 experts, entrepreneurs and eminent industrialists responded to the questionnaire with their valuable suggestions and views. Fig. 4.2. shows the statewise distribution of such responses all over the country. In view of the responses from 12 leading industries already covered as shown in fig. 4.1 under "Area" in Andhra Pradesh, the apparent lack of response from experts from Andhra Pradesh and neighbouring Orissa regions is not significant.

The list of Entrepreneurs and experts who responded is given in Annexure 4.1.

4.3. Industries

The industries that responded to the questionnaire have been classified under the following three main groups.

(a) Engineering Industries
(b) Process Industries
(c) Others

These have further been classified into the following categories for deeper analysis:

(1) Heavy Engineering Industries including Mining Industries.

(2) General Engineering and Consultants.

(3) Textiles, Paper, Cement and other Process Industries.

(4) Petrochemical and Pharmaceutical industries.

(5) Electrical and Electronic industries.

The number of workers and technicians employed by the firms that replied to the questionnaire has been given in Table 4.1. below, grouped industrywise:

TABLE 4·1

Group of Industry	Number of Workers	Number of Technicians
1. Heavy Engineering, including mining industries	99,914	9,578
2. General Engineering & Consultants.	32,701	6,073
3. Textiles, paper, cement and other process industry	38,742	2,197
4. Petro-Chemicals and Pharmaceutical industry . . .	5,142	1,604
5. Electrical and Electronic Industries.	14,360	3,712
TOTAL . . .	1,90,859	23 16

The classified list of industries, which replied to the questionnaire is given in Annexure 4.2.

On the whole this survey covers organisations employing totally 1,90,859 workers and 23,164 technicians spread over the whole country. According to a recent estimate by the Ministry of Education and Youth Services about 200,000 diploma holders are working in the various organizations in the country. Thus the present survey covers 11.50 per cent of the total number of technicians employed in the country and the survey may be considered sufficiently representative.

4.4. Aspects of Polytechnic Education.

The questionnaire cover the following issues affecting Polytechnic Education:

Q.1. Deficiencies of the present system and suggestions for evolving a suitable pattern of polytechnic education rectifying the deficiencies.

Q. 2. Qualities that are normally looked for by prospective employers while recruiting technicians, and the methods they employ to assess those qualities.

Q. 3. The need for and the existence of organized training programme offered to fresh entrants in industries, and duration of such programmes.

Q. 4. Basis of promotions and opportunities that exist in the organizations for the technician to move to higher positions.

Q. 5. Plans for retraining of technicians and sending them to refresher courses in the fields in which they are offered.

Q. 6. Opportunities available in industries for technical teachers to get industrial experience.

Q. 7. Industry-Institute co-operation by way of mutual exchange of experts and by way of industry offering supervised training to students in special fields.

A Proforma of the Questionnaire is annexed as Annexure 4.3.

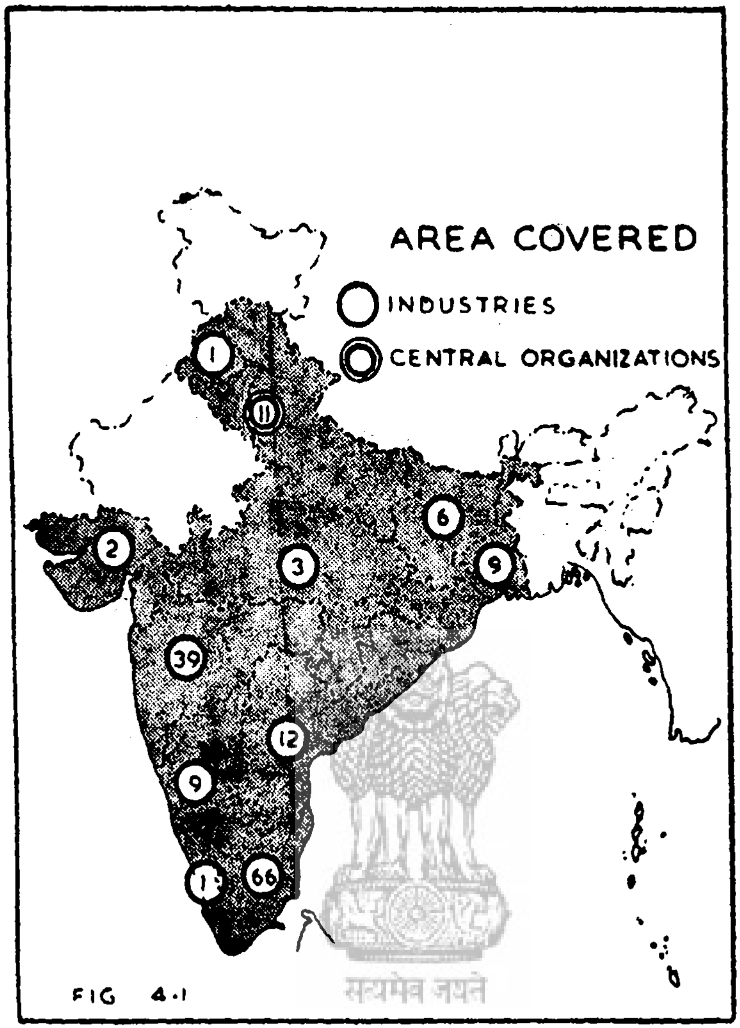

FIG 4·1

© *Government of India Copyright.*

1. *The territorial waters of India extend into the sea to a distance of 12 nautical miles measured from the appropriate base line.*
2. *Bhutan is a state in special treaty relations with India.*
3. *The boundary of Meghalaya shown on this map is interpreted from the Assam Reorganisation (Meghalaya) Act 1969, but has yet to be verified.*
4. *Based upon the Survey of India map with the permission of the Surveyor General of India.*

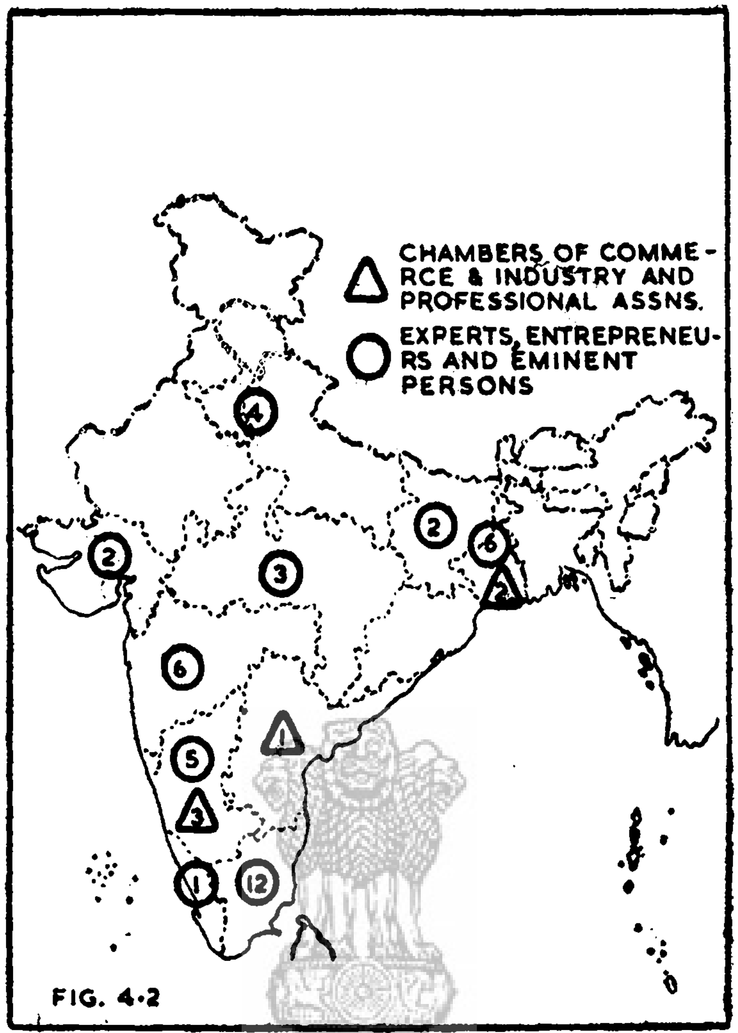
△ CHAMBERS OF COMMERCE & INDUSTRY AND PROFESSIONAL ASSNS.
○ EXPERTS, ENTREPRENEURS AND EMINENT PERSONS
4
2
6
2
2
3
6
1
5
3
1
12

FIG. 4·2

© Government of India Copyright.

1. *The territorial waters of India extend into the sea to a distance of 12 nautical miles measured from the appropriate base line.*
2. *Bhutan is a state in special treaty relations with India.*
3. *The boundary of Meghalaya shown on this map is interpreted from the Assam Reorganisation (Meghalaya) Act 1969, but has yet to be verified.*
4. *Based upon the Survey of India map with the permission of the Surveyor General of India.*

ANNEXURE 4.1

LIST OF EXPERTS, ENTREPRENEURS AND EMINENT PERSONS WHO HAVE REPLIED TO THE QUESTIONNAIRE

S. No.	Address	Field Allotted
1.	Shri D. S. Desai Director and Chief Engineer M/s. M. N. Dastur & Co. P. Ltd B-17, Mission Row Extension Calcutta-13	Civil Engineering
2.	Shri A. L. Mudaliar Managing Director The Alkali & Chemical Corporation of India Ltd 18, Strand Road Calcutta-10	General
3.	Shri M. Rama Brahmam Managing Director M/s. Madras Refineries Ltd 122-D, Mount Road Madras-6	Petro-Chemicals
4.	Shri E. N. Narayanaswamy Dy. Director of Industries and Commerce, Govt. of Tamilnadu Madras-5	General

S. No.	Address	Field Allotted
5.	Shri K. V. Varatharajan Works Manager M/s. Ashok Leyland Ltd, Ennore, Madras	Automobile
6.	Shri G. K. Devarajulu Chairman Textile Machinery Dev. Council Avanashi Road, Coimbatore-18	Textile Machinery
7.	Shri Shriravi Kirloskar M/s. Kirloskar Elec. Co. Ltd. Industrial Suburb, Rajaji Nagar, Bangalore-3	Electric Motors and Generators
8.	Dr. S. M. Das Gupta Principal, Govindram Saksaria Technological Institute, Indore-3.	General
9.	Shri A. D. Chandrahari Technical Director West Coast Paper Mills Srinivas House, Waudhby Road Bombay-1	Paper Industry
10.	Shri K. Sreenivasan Director South India Textile Research Association Coimbatore-14	Textile Industry
11.	Shri J. G. Parikh Director The Silk and Art Silk Mills Research Association Bombay-25 DD	Artificial Fibre Industry
12.	Air Vice Marshall A. S. Bikhy Managing Director Hindustan Aeronautics Ltd Hindustan Aircraft P. O. Bangalore-17	Aeronautics
13.	Shri B. R. R. Iyengar Member (Hydro-Elec.) West Block II, R. K. Puram New Delhi-22	Electric Power generation and distribution system
14.	Shri A. Subramaniam Chief Engineer State Eelectricity Board 157, Mount Road Madras-2	Electric power generation and distribution system
15.	Prof. A. C. Pandya Head of Deptt. of Agrl. Engg. Indian Institute of Technology, Kharagpur	Agricultural Implements
16.	Shri Nanubhai B. Amin Messrs. Jyoti Ltd, Baroda	Power Driven Pumps
17.	Prof. J. N. Hate Prof. of Automobile Engineering Victoria Jubilee Technical Institute Matunga, Bombay-19	Automobiles

S. No.	Address	Field Allotted
18.	Shri S. P. Chitnis Messrs. Chitram & Co. Main Road, Madras-13	Cranes
19.	Shri K. V. Sardesai Chief Executive International Tractor Co. of India Ltd. Bombay	Tractors
20.	Shri S. K. Parthasarathy Special Director Tube Investments of India Ltd Madras-1	Bicycles
21.	Shri R. Muthuswamy Messrs. Hindustan Steel Ltd Bhilai	Iron & Steel
22.	Prof. P. J. Madan Maharaja Sayajirao University of Baroda Baroda	General
23.	Dr. V. Ramachandran Regional Director National Productivity Council 21, 9th Main Raod, III Block West Jayanagar, Bangalore-11	General
24.	Lt. Gen. R. A. Loomba Chairman The Institution of Engineers (India) 8, Gokhale Road, Calcutta-20	General
25.	Shri K. Narayan Secretary The Institution of Engineers (India) Andhra Pradesh Centre Khairatabad, Hyderabad-4	General
26.	Shri J. S. Srinivasa Rao General Manager The Mysore Paper Mills Ltd Bhadravati, Mysore	General
27.	Shri I. J. Sharma Deputy Director (TM & S) Central Water & Power Commission Yamuna Project, Dehradun	General
28.	Prof. K. U. Gosavi Professor & Head, Department of Electrical Engg. Birla Institute of Technology, Mesra, Ranchi	General General
29.	Shri B. L. Fernandez Superintendent of Training Tata Iron & Steel Co. Ltd. Jamshedpur	Iron & Steel

S. No.	Address	Field Allotted
30.	Shri B. Das Gupta Training Superintendent Machinery Manufacturers Corpn. Ltd. P/61B, Circular Garden Reach Road, Kidderpore, Calcutta-43	
31.	Shri R. Veerabasappa Divisional Manager (IE) The Mysore Iron and Steel Ltd Bhadravati, Mysore State	Iron & Steel
32.	Shri P. N. Pillai Works Manager, S. & T. Workshops Podanur, Coimbatore	Railways
33.	Shri Swarnendu Kumar Das Principal Technical Teachers' Training Institute 7, Mourbhanj Road, Calcutta-23	General
34.	Shri P. C. Mittra Chief Mechanical Engineer Commissioners for the Port of Calcutta Calcutta	Ports
35.	Shri P. B. Adur The Associate Cement Cos. Ltd. Cement House 121, Maharashi Karve Road, Bombay-20	Cement
36.	Shri B. K. M. Nair Manager (Training) Heavy Electrical (India) Ltd Bhopal	Eelectrical Industry
37.	Shri A. P. Mahadevan Hindustan Lever Ltd P. O. Box 409, Bombay	Vegetable Oils
38.	Shri C. S. Sridharan Asstt. Director General (Engg) Indian Council of Agrl. Research Krishi Bhavan Dr. Rajendra Prasad Road, New Delhi-1	Agriculture
39.	Shri S. G. Ramachandran Chief Engineer Kirloskar Eelectric Co. Ltd. Bangalore-3	Electric Motors
40.	Dr. V. Seshadri Asstt. Professor Deptt. of Metallurgical Engg Indian Institute of Technloogy Kanpur	Mining and Metallurgy
41.	Shri C. Sundaram Chief Superintendent, Training Fertilisers & Chemicals (Trav) Ltd. Udyogamandal P.O. Alwaye	Chemicals

ANNEXURE 4·2

CLASSIFIED LIST OF INDUSTRIES WHO REPLIED TO THE QUESTIONNAIRE

Field	No. of replies to questionnaire received
A.—ENGINEERING INDUSTRIES	
1. *Mechanical Engineering*	
1·01 Agricultural Implements	..
1·02 Power Driven Pumps	2
1·03 Diesel Engines	..
1·04 Sugar Mill Machinery	..
1·05 Textile Machinery	6
1.06 Automobiles	12
1·07 Cranes and other structural fabrications	3
1·08 Tractors and Agricultural Machines	3
1·09 Bicycles	2
1·10 Heavy Machines Building Industry	4
1·11 Railways	3
1·12 Navigational Industries—Shipping and Port Maintenance	4
1·13 Aeronautics and Air Transport	2
1·14 Scientific Instruments	..
1·15 Tool Design and Machine Tools	2
2. *Electrical Engineering*	
2·01 Airconditioning and Refrigeration	..
2·02 Electric Motors and Generators	10
2·03 Radios and T. V. Sets	..
2.04 Telephone Industries	1
2·05 Electronics Industries	6
2·06 Starters, Switches and Transformers	..
2·07 Heavy Electrical Industry	3
2·08 Electric Power Supply and Cables	9
3. *Civil Engineering*	
3·01 Irrigation—Major and Minor	..
3·02 Buildings and Roads	..
3·03 Civil Engineerig and Structurals	14
4. *Mining and Metallurgical Industries*	
4·01 Coal	..
4·02 Iron and Steel Industries (including Steel castings and forgings)	16
4·03 Copper Industries	..
4·04 Aluminium Industries	..
4·05 Others—Non-ferrous	6

Field	No. of replies to questionnaire received
B. PROCESSING INDUSTRIES:	
B·01 Fertilisers	..
B·02 Chemical Industries	5
B·03 Drugs and Pharmaceuticals	..
B·04 Paints	..
B·05 Rubber and Plastic Industries	..
B·06 Photo Films	..
B·07 Petro Chemicals	9
B·08 Sugar Industry	..
B·09 Coffee and Tea Industries	..
B·10 Vegetable Oil Industry	3
B·11 Leather and leather products	..
B·12 Paper Industry	5
B·13 Cement Industry	4
B·14 Textile Industry	9
B·15 Man-made Fibre Industry	11
C. UNCLASSIFIED INDUSTRIES	
C·01 Small Scale Industries	5
C·02 Other Industries	5

ANNEXURE 4·3

QUESTIONNAIRE

PART A: STATISTICAL DATA

1. NAME OF ORGANISATION ————————————————

2. CLASSIFICATION Engg. industry ( ) Process industry ( )

3. SKILLED WORKERS ON ROLL (approx) ( )

4. TECHNICIANS*	Engg. degree holders	Engg. diploma holders	Job experience only
as laboratory technicians and analysts	( )	( )	( )
as design and production assistants	( )	( )	( )
as sales, stores, costing assistants	( )	( )	( )
5. ENGINEERS & TECHNOLOGISTS in executive and managerial positions	( )	( )	( )

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*A note describing the role of technicians is given at the end of the questionnaire

QUESTIONNAIRE PART B:—VIEWS

(Top management views with reference to the following topics will be most valuable).

1. Education and Training of Diploma Holders

In your opinion do the present day diploma holders possess adequate technical knowledge and skill to function effectively as technicians?

If not, please suggest whether any one or more of the following measures may be taken, in future, in the education and training of the students in our Polytechnics?

(i) Introducing specific areas of specialisation (for example, in Production Engineering, Industrial Electronics, Building Construction, Process Metallurgy, Oil Refining, Fertiliser Technology, Textile Processing, Plastics etc.) instead of the traditional broad fields of Engineering and Technology.

(ii) Sandwiching, training-in-industry between definite durations of accademic learning in polytechnics.

(iii) Post-academic training by the employer to suit his needs.

If you feel any other remedial measures would be appropriate, please suggest.

2. Selection and Placement of Technicians

While recruiting persons for employment as technicians, what qualities do you look for and how are they assessed?

3. Training Programme

Please state whether you have any organised training programme for all fresh entrants who will work as technicians. If so, please furnish the following details:

Duration of training: on the shop floor—academic

Area in which special training is given.

4. Promotional Opportunities for Technicians

What opportunities do exist in your organisation for technicians with diploma qualification to get promoted as executive and managerial engineers?

On what basis are such promotions made?

5. Retaining of Technicians

Do you have plans to retrain your technicians to meet the possible future technological needs in your organisation?

If so, indicate briefly the areas of training.

Would it be desirable that this retraining be arranged in selected technicial institutions where facilities are available in the form of refresher courses?

6. Training of Technical Teachers

One of the ways of improving the quality of teaching in our Polytechnics is to provide opportunities for the teachers to acquire industrial experience. Would it be possible for your firm to provide this facility?

7. Co-operation from Industry

For Polytechnics to turn out technicians suitable to industries would your organisation be able to provide assistance in the form of:

Supervised training of the students in specific fields of specialisation.

Making available senior members of your staff to give a course of lectures on specialised topics to the final year students of the Polytechnics.

Suggested Description of a Technician for the purpose of the Questionnaire

A 'technician' in most cases carried out a function between qualified scientists, professional engineers and other technologists on the one hand and the skilled craftsmen and operatives on the other. He is one who can apply in a responsible manner proven techniques which are commonly understood by those who are experts in that branch of science, engineering or other technology or those techniques specially prescribed by qualified scientists, professional engineers or other technologists.

Under general professional direction, or following established scientific or engineering techniques, he is capable of carrying out duties which may be found among the list of examples set out below. Such work often calls for the exercise of a high degree of specialised skill and ability to recognise the unusual or abnormal occurrence whether in the laboratory, in the factory, in processing etc. In indentifying technicians, it is essential to consider the job being done rather than the educational qualifications held.

2. Typical Duties of a Technician

(i) Working on the detailed design and development or on the manufacture, erection or commissioning of equipment and structures;

(ii) drawing, estimating, inspecting and testing equipments;

(iii) use of measuring instruments;

(iv) operating, maintaining and repairing machinery, plant and services and locating defects therein;

(v) process control;

(vi) activities connected with research and development, testing of materials and components;

(vii) advising customers;

(viii) servicing equipment, data processing;

(ix) work study;

(x) assisting qualified scientists in such activities as physical measurements, collection and evaluation of experimental observations, the devising and setting up of experimental apparatus, the preparation of chemical or biological culture or similar preparation in other fields, photographic work, the taking and routine testing of product samples, chemical analysis, etc.

5. Findings

5.1. General Quantitative Observations

In Table 5.1. the distribution of the number of units grouped according to the number of skilled-workers employed therein is presented.

It is observed that the mining industry, the air transport and aeronautics industry employ more than 10,000 workers per unit. The Railway Workshops, the Bombay Road Transport and some of the major irrigation projects employ workers ranging from 5000 to 10000 per unit. The Heavy machine building industry, the Textile Machinery manufacturing units, a few automobile manufacturing units, the Heavy Electrical plants, the Fertiliser units and the Iron and Steel plants employ 2500 to 5000 workers per unit. The Cotton Textile Manufacturing Industry has its number of workers mostly falling in the range of 1000 to 2500 workers-per-unit group. The other medium sized units, with respect to number of workers employed, are found in the Light engineering and other process industries. Small units employing less than 50 skilled workers per unit are mostly the small scale industries and a few process industries.

It is found that on an average in one unit 4020 skilled workers in mining and metallurgical industries, 1675 skilled workers in Mechanical Engineering industries, 1025 in Electrical Engineering Industries and 1040 in Processing Industries, are employed. These figures also conform to the familiar pattern of employment potential in various types of industries.

The above data are only of general interest. On an average the number of skilled workers per technician comes to on an average about 8 for all the 135 units surveyed which cover mostly all sizes of industrial units, large scale, medium and small scale. There are industries which require a very large number of operatives and there are others which require a substantial number of persons of the technician's level and not operatives. The employment potential for technicians depends mainly on the nature of each industry.

5.1.1. Qualifications of Existing Technicians

Industries were requested to give information on the number of technicians they employ, classified according to their qualifications, namely (a) Engineering degree, (b) Diploma and (c) Job experience only. They were supplied with the definition of the term "Technician", so that they may adopt a uniform criterion in deciding whether a particular employee is a technician or not (whatever designation they may have given to that person in their organization). From the data received the number of technicians possessing the three types of qualifications referred to above was re-worked as a percentage of the total number of technicians employed. It was intended to compare the strength of the technicians in industry with reference to their qualifiations. The data are presented in Tables 5.2, 5.2.1, 5.2.2 and 5.2.3.

Table 5.2 brings out the fact that the number of industries employing engineering degree holders as technicians is relatively small. Out of 123 industrial units 95 have less than 30 per cent of their technicians having an engineering degree.

The table also reveals that persons with job experience occupy a larger percentage of positions as technicians.

Taking together all the industrial units surveyed, it is found that 36 per cent of the posts of technicians are held by engineering diploma holders as against 48 per cent by persons with job experience only. Therefore, it is the responsibility of the polytechnics to educate and train not only the fresh entrants to have engineering diploma, but also those existing technicians having only job experience.

In Table 5.21 among the technicians employed in the various industrial units, the percentage of diploma holders is presented in the form of a frequency distribution. Comparing this table with the table 5.2 it is found that about 36 per cent of the technicians employed in the industries are diploma holders. It is also found from table 5.2 that about 16 per cent of the technicians employed are degree holders. The rest not only comprise those persons who have become technicians through job experience, but also those with University degrees in Arts and Sciences. The persons with job experience constitute 48 per cent of the technicians on the whole. Thus it is found that the majority of the technicians are persons with job experience, with the diploma holders coming in the next place.

The following industries have recruited engineering degree holders for over 60 per cent of their technicians' posts:

Electric Motors and Generators

Electronic Industry

Chemical Industry

Paper Industry

Cement Industry

A few units of Man-made Fibre Industry.

The following industries have recruited engineering *diploma holders* for over 60 per cent of their technicians' posts:

- Automobiles
- Navigation, Ship Building and Port Maintenance
- Tool Design
- Metallurgical Industry
- Paper Industry
- Cotton Textile Industry

The following industries have recruited *persons with job experience* only for over 50 per cent of their technicians' posts:

- Textile Machinery Manufacture
- Railways
- Some of the Electric Motors and Generators Manufacturers.
- Some of the Metallurgical industrial units
- Petro-Chemicals
- Cement industry and Man-made fibre industry.

The preference to persons with job experience seems to be very pronounced in Textile Machinery Manufacture, Railways, Petro-Chemicals, Cement and Man-made Fibre industries.

An interesting feature of the trend in almost all industries is that they do not completely do away with one or the other types of persons *viz.* graduates, diploma holders or persons with job experience only. However, there seems to be less preference to recruit persons with job experience only as technicians.

5.1.2. **Promotional Opportunities**

Data were obtained from Industrial units regarding the number of persons working as engineers and in managerial positions. Their qualifications that is (a) possession of engineering degree (b) possession of engineering diploma and (c) job experience only were found out. Then the total number of persons having the above qualifications working both as technicians and at higher levels put together was calculated. Finally the percentage of persons with each qualification occupying technician posts as a percentage of the total number of persons with that qualification was calculated. The results are presented in Table 5.3.

Table 5.3 brings out the fact that in 65 industrial units almost all the engineering diploma holders are employed as technicians only and there is none who occupies a higher position. In another 3 units 80-90 percent of the engineering diploma holders work as engineers and managers. In another seven units, more than 50 percent of their engineering diploma holders are in higher positions. The industries in which diploma holders are found occupying higher positions are Textile Industry, and the Man-made Fibre Industry. Therefore, the **inference is that in a large majority of industries diploma holders recruited as technicians continue in the same category. On** an overall basis it is observed that 83 per cent of the engineering diploma holders continue to work as technicians, and only the balance of 17 per cent find their way up to higher ranks.

With respect to engineering degree holders, in 15 out of the 120 units almost all the engineering degree holders continue to work as technicians. This is particularly so in the Man-made Fibre Industry where degree holders and diploma holders appear to be treated on the same line. In 65 out of the 120 units more than 50 per cent of the degree holders are found to occupy higher positions. As a matter of fact in 19 of these, almost 100 per cent of the degree holders are occupying higher positions. Some of the industries in which more than 50 per cent of the degree holders are found working as technicians are:

- Textile Machinery Manufacture
- Automobiles
- Tractors
- Electric Motors and Generators
- Electronics Industry
- Heavy Electrical Industry
- Civil Engineering and Structurals
- Chemical Industry
- Paper Industry
- Man-made Fibre Industry.

In 81 out of 120 industrial units, persons with job experience work as technicians only and are not found in higher ranks. In the Man-made fibre industry some of the persons of this type have moved up from technician to higher levels.

Tables 5.3.1, 5.3.2, 5.3.3 provide an idea about the occupational level (*viz,* technicians or managers) of diploma holders, degree holders and persons with job experience. From the table 5.3.1 also, it is found on an average about 80 per cent of the diploma holders remain at the same level only whereas only about 20 per sent move to the Managerial cadre. Degree holders, on the contrary, are mostly occupying managerial and executive posts in almost all the units irrespective of the industry.

Applying the Chi, square test to these percentages, it is observed that there is a very high 'significance' leading to the inference that engineering graduates have better opportunities to rise up than others. Relatively therefore, engineering diploma holders have less vertical mobility than engineering degree holders.

5.1.3. Jobs Entrusted to Technicians

For purposes of the present survey, Technicians were classified into three broad groups, namely,

(1) Laboratory Technicians and analysts

(2) Design and Production assistants

(3) Sales, Stores and costing assistants

The percentages of technicians discharging the above duties were calculated and the results are given in Table 5.4.

From Table 5.4 it is observed that 20 per cent of technicians are employed as laboratory assistants and analysts, while 69 per cent are working as design and production assistants. The rest 11 per cent are working as Sales, Stores and costing assistants. In the electronic industry, 36 per cent and in Petro-Chemicals industry 55 per cent are working as laboratory technicians and analysts.

Tables 5.4.1, 5.4.2, 5.4.3 reveal the composition of technicians on the basis of, their occupations. It is found that the percentage of laboratory technicians and analysts in processing industries in more than that in Engineering Industries. In Mechanical and in Electrical Engineering Industries, the percentage of technicians working as Design and Production assistant is predominant. From Table 5.4.3 it is found that about 10 per cent of the technicians only are in the sales, costing wing.

There are very few technicians doing laboratory work in the engineering industries. Generally the engineering industries employ a large number of technicians as design and production assistants. Sales, Stores and Costing assistants, are found largely employed in Electric Motors and Generators Industry, Electronics industry and to a lesser extent in Textile Machinery Industry, Bicycle industry, and in the Cotton Textile industry. Development of a larger number of technicians in Sales and Servicing activities, more particularly in engineering industries, where the sales turnover is large or where the product is more sophisticated, may be found necessary in the coming years.

At present 69 per cent of technicians are in design and production jobs and it is the responsibility of polytechnics to educate and train technicians needed for this job in variety of industries. It seems reasonable also to fore see that more technicians would, in future, be required to undertake jobs in the laboratories and in sales and servicing.

5.1.4. Ratio of Technicians to Engineers

The number of technicians employed per engineer was calculated from the data received from industries. These ratios are presented in Table 5.5.

It is observed that in the Man-made Fibre Industry there are units working without an engineer but with technicians only. Barring this, there are engineers and technicians in almost all industries. In Textile Machinery Manufacturing Industry, there is one engineer for every 24 technicians. In the Heavy Machine Building Industry there is one engineer for every 40 technicians. Leaving aside the Man-made Fibre Industry, there are about 8 technicians on an average for every engineer employed. Some of the industries in which less than 10 technicians per engineer are found are:

The Textile Machinery Manufacturing units
Automobiles industry
Tractor industry
Bicycle industry
Aeronautics and air transport industry
Machine tool industry
Electronics industry
Iron and steel industry
Metallurgical industry
Chemical industry
Petro-chemicals
Paper industry
Cement industry and the Cotton Textiles manufacturing industry.

5.1.5. Summary and Conclusions

The size of units as judged from the number of skilled workers each unit employs, differs very widely from industry to industry and also from unit to unit in the same industry.

The potential for employment of technicians cannot be judged with reference to the number of skilled workers employed in a unit. This depends mainly on the nature of activity of each unit.

Persons with engineering degree occupy 34 per cent of the total number of technicians posts. These percentages for engineering diploma holders and for persons with job experience respectively are 45 and 21. The polytechnic education whose main function is to educate and train technicians for the industry, must also provide proper education for those persons with job experience only (21 per cent total technicians) who are likely to rise up to the ranks of technicians in the industry.

There is greater vertical mobility of technicians with engineering degrees to rise to the positions of engineers and managers. Such chances are relatively less for technicians who possess engineering diploma or only job experience.

Of the technicians, 69 per cent are working as design and production assistants. Next in importance are technicians working as Laboratory Assistants and Analysts (20 per cent) and as Costing Sales and Store Assistants (11 per cent).

The nature of the industry often determines the nature of job that the technician in the industry is to be entrusted with. In processing industries most of the technicians are working as Laboratory analysts whereas in Heavy Engineering Industry, the majority of the technicians are in design and production line only.

Polytechnic education should take note of this situation in designing curricula suited to these needs.

There is a very wide variation in the ratio of technicians to engineers. The range of variation is as wide as just 2 technicians, and as many as 45 technicians per engineer. The average is about 15 technicians for each engineer. It is observed that many of the process industries such as petro-chemicals, chemicals, paper, cement and cotton textile and some engineering industries such as electronics, automobiles, metallurgy etc. employ proportionately less number of technicians as compared with engineers. The scheme of polytechnic education should attempt to train technicians to meet the needs of the industries.

TABLE 5·1

No. of skilled workers	No. of Units
0—50	24
51—250	29
251—500	15
501—1000	32
1001—2500	19
2501—5000	11
5001—10000	3
Over 10000	2
Total No. of Units	135
Average workers per unit	1414

TABLE 5.1.1

Frequency distribution of the number of skilled workers employed in a unit (Industry-wise)

No. of skilled workers	Number of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & Other Indus.	Total
0—50	5	4	1	3	6	5	24
51—250	8	7	1	2	11	..	29
251—500	4	5	..	1	5	..	15
501—1000	10	3	..	5	14	..	32
1001—2500	7	5	..	..	6	..	19
2501—5000	3	4	..	1	3	..	11
5001—10000	2	..	..	..	1	..	3
Over 10000	1	..	..	1	..	..	2
TOTAL	40	29	2	13	46	5	135
Average no. of workers per unit	1675	1025	100	4020	1040	25	

TABLE 5·2

Technicians classified according to their qualifications as percentage of the total number of technicians.

Percentage	Qualifications		
	Diploma holders	Degree holders	Job Experience only
	Number of Units		
0—10	13	53	28
11—20	14	23	11
21—30	10	19	13
31—40	21	16	19
41—50	21	6	12
51—60	16	3	11
61—70	13	1	10
71—80	7	1	9
81—90	1	..	6
91—100	7	1	4
Total No. of Units	123	123	123
Percentage of Technicians with respective qualifications*	36	16	48

TABLE 5.2.1

Frequency distribution of the percentages of technicians who are diploma holders.

Percentages	Number of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metal. Indus.	Processing Indus.	Small Scale & Other Indus.	Total No. of Units
0—10	3	3	..	1	6	..	13
11—20	6	4	..	..	4	..	14
21—30	4	1	..	1	3	1	10
31—40	6	3	..	2	9	..	21
41—50	5	4	1	1	9	1	21
51—60	7	4	..	1	4	..	16
61—70	2	3	..	..	6	2	13
71—80	4	..	..	2	1	..	7
81—90	..	..	..	..	1	..	1
91—100	1	2	..	..	3	1	7
TOTAL	38	24	1	8	46	6	123
Average percentage of technicians who are diploma holders*	41	38	..	37	24	29	..

*Calculated from the original data.

TABLE 5.2.2

Frequency distribution of percentages of technicians who are degree holders.

Percentages	Number of Units Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus	Small Scale & other Indus.	Total No. of Units
0—10	18	8	..	4	20	3	53
11—20	7	3	..	1	9	3	23
21—30	8	3	..	3	5	..	19
31—40	3	5	1	..	7	..	16
41—50	1	1	..	..	4	..	6
51—60	..	3	..	..	..	..	3
61—70	..	1	..	..	..	..	1
71—80	1	..	..	..	..	..	1
81—90	..		..	..	..	..	..
91—100	..	..	..	..	1	..	1
TOTAL	38	24	1	8	46	6	123
Average percentage of technicians who are degree holders*	11	16	..	9	23	26	..

TABLE 5.2.3

Frequency distribution of percentages of technicians who have job experience only.

Percentages	Number of Units Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus	Small Scale & Other Indus.	Total No of Units
0—10	9	8	..	1	9	1	28
11—20	2	4	..	1	3	1	11
21—30	3	1	1	1	7	..	13
31—40	4	2	..	1	9	3	19
41—50	4	3	..	..	5	..	12
51—60	5	2	..	..	4	..	11
61—70	4	..	..	2	3	1	10
71—80	3	2	..	..	4	..	9
81—90	3	2	..	..	1	..	6
91—100	1	..	..	2	1	..	4
TOTAL	38	24	1	8	46	6	123
Average percentage of technician who possess job experience only*	48	46	54	53	..	45	..

*Calculated from the original data.

TABLE 5·3

No. of persons working as technicians expressed as a percentage of the total number of technicians and higher officers.

Percentage	Qualifications		
	Diploma holders	Degree holders	Job experience only
	Number of Units		
0—10 . . .	1	19	13
11—20 . . .	2	8	1
21—30 . . .	..	9	1
31—40 . . .	4	11	3
41—50 . . .	3	18	6
51—60 . . .	5	8	2
61—70 . . .	5	9	2
71—80 . . .	14	14	3
81—90 . . .	21	9	8
91—100 . . .	65	15	81
TOTAL . .	120	120	120
Percentage of persons working as technicians .	83	49	76
Higher Officers .	17	51	22

TABLE 5·3·1

Frequency distribution of the number of diploma holders serving as technicians as a percentage of the total diploma holders both at the technician and higher level

Percentages	Number of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & Other Indus.	Total No. of Units
0—10	..	1	..	..	..	..	1
11—20	..	1	..	..	1	..	2
21—30	..	..	..	..	..	..	..
31—40	1	..	..	1	2	..	4
41—50	3	..	..	..	..	..	3
51—60	2	2	..	..	1	..	5
61—70	1	2	..	..	1	1	5
71—80	5	3	..	1	5	..	14
81—90	11	3	..	..	6	1	21
91—100	15	12	1	6	27	4	65
Total No. of Units	38	24	1	8	43	6	120
Average percentage	81	78	..	85	85	86	..

TABLE 5·3·2

Frequency distribution of the number of technicians who are degree holders as a percentage of the total degree holders.

Percentages	Number of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & other Indus.	Total No. of Units
0—10	6	3	..	3	5	2	19
11—20	..	2	..	1	3	2	
21—30	5	1	..	..	3	..	9
31—40	6	2	..	..	3	..	11
41—50	5	1	..	3	9	..	
51—60	2	2	..	..	4	..	
61—70	3	5	..	..	1	..	9
71—80	8	3	..	1	2	..	14
81—90	2	5	..	..	1	1	9
91—100	1	..	1	..	12	1	15
Total No. of Units	38	24	1	8	43	6	12
Average Percentage	46	53	..	30	54	..	..

TABLE 5·3·3

Frequency distribution of percentage of technicians who have only job experience amongst the job experienced people

Percentages	No. of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & other Indus.	Total No. of Units
0—10	1	1	..	2	6	3	13
11—20	1	..	..	..	..	..	1
21—30	1	..	..	..	..	..	1
31—40	2	1	..	..	..	..	3
41—50	3	2	..	..	..	1	6
51—60	..	1	..	..	1	..	2
61—70	..	..	..	..	2	..	2
71—80	1	..	..	..	2	..	3
81—90	3	1	..	1	3	..	8
91—100	26	18	1	5	29	2	81
Total No. of Units	38	24	1	8	43	6	120
Average Percentages	77	53	..	..	76	..	..

TABLE 5·4

Percentage of technicians doing various jobs.

Percentage	Jobs		
	As Laboratory Technicians & Analysts	As Design & Production Assistants	As Sales, Stores & Costing Asstt.
		Number of Units	
0—10	72	10	78
11—20	16	3	17
21—30	10	1	15
31—40	6	4	7
41—50	5	15	2
51—60	1	5	1
61—70	1	9	2
71—80	2	17	..
81—90	4	20	..
91—100	6	39	1
TOTAL	123	123	123
Percentage of Technicians working in the respective categories	20	69	11

TABLE 5·5·1

Frequency distribution of percentage of technicians as Laboratory Technicians and Analysists (Industries-wise)

Percentages	No. of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & other Indus.	Total No. of Units
0—10	27	14	1	4	23	3	72
11—20	3	3	..	1	7	2	16
21—30	2	2	..	2	4	..	10
31—40	..	1	..	1	3	1	6
41—50	1	1	..	..	3	..	5
51—60	..	1	..	..	..	..	1
61—70	..	..	..	..	1	..	1
71—80	1	1	..	..	..	..	2
81—90	2	1	..	..	1	..	4
91—100	2	..	..	..	4	..	6
Total No. of Units	38	24	1	8	46	6	123
Average Percentage	19	19	..	..	24	..	..

TABLE 5·4·2

Frequency distribution of percentage of technicians as Design & Production Assistants

Percentage	No. of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & Other Indus.	Total No. of Units
0—10	2	1	..	1	6	..	10
11—20	2	1	..	..	..	..	3
21—30	..	1	..	..	..	..	1
31—40	..	1	..	..	1	2	4
41—50	1	5	..	1	7	1	15
51—60	2	1	..	..	2	..	5
61—70	4	1	..	1	3	..	9
71—80	6	5	..	1	4	1	17
81—90	9	2	..	1	6	2	20
91—100	12	6	1	3	17	..	39
Total No. of Units	38	24	1	8	46	6	123
Average Percentage	74	65	..	..	68	..	..

TABLE 5·4·3

Frequency Distribution of Technicians as Sales Stores and a Costing Assistant

Percentages	No. of Units						
	Mech. Engg. Indus.	Elec. Engg. Indus.	Civil Engg. Indus.	Mining and Metall. Indus.	Processing Indus.	Small Scale & Other Indus.	Total No. of Units
0—10	22	11	1	6	36	2	78
11—20	7	4	..	1	5	..	17
21—30	5	5	..	..	4	1	15
31—40	3	..	..	1	1	2	7
41—50	..	1	..	..	..	1	2
51—60	..	1	..	..	..	..	1
61—70	..	2	..	..	..	..	2
71—80	..	..	..	..	..	..	..
81—90	..	..	..	..	..	..	..
91—100	1	..	..	..	..	..	1
						..	1
Total No. of Units	38	24	1	8	46	6	123
Average Percentage	7	16	..	..	8	..	..

TABLE 5·5

Ratio of number of technicians employed per engineer

Ratios (Technician/Engineer)	No. of Units
1 : 1	27
2 : 1	14
3 : 1	13
4 : 1	14
5 : 1	10
6 : 1	4
7 : 1	8
8 : 1	2
9 : 1	5
10 : 1 & above	29
TOTAL	126
Average ratio to Technician to Engineers	15

5.2. Views of Industries on Education and Training of Diploma Holders

The questionnaire given in Appendix 4.3 was sent to Experts Associations and Entrepreneurs. The classified list of industries which respondent is given earlier in Annexure 4.2.

5.2.1. Education and Training Imparted to Diploma Holders

A broad summary of the comments received from various industries on the education and training now given to the diploma holders is presented below:

The present day diploma holders do not possess adequate knowledge according to 78 per cent of the replies. They do not possess the necessary skill according to 96 per cent of the replies. In general, there is a feeling among 18 per cent of the respondents that even though they possess sufficient knowledge, it is too wide to be applicable to any specfic job in the field. It is felt that some diploma holders do attain the necessary abilities after about one year of training. There is a strong support to the idea of specialized instruction and training in a number of fields instead of the broad based education now existing. A suitably broad based study is however held to be necessary before any specialised study is undertaken. Some have expressed doubts about the feasibility of introducing an ideal sandwich system. Howerver, restricted specialization and sandwiching gradually introduced is indicated as an initial step in the reorganization of the ploytechnic curriculum. Aptitude tests for students, industrial experience for teachers. physical fitness of candidates and continuous curriculum development are indicated as some necessary lines of improvement. Additional subjects such as industrial hygiene and safety are held to be very necessary. A closer co-ordination between industry and education is held to be a very essential condition.

Suggestions received from a few industries are given below. They are also diagrammatically presented in fig. 5.2.1

Petro Chemicals: Of the respondents, 54 per cent show support to the system of education with specialization and Sandwiching. Sandwich system with students sponsored from industry is considered desirable.

Heavy Engineering: About 81 per cent of the replies show a pronounced support to a system of sandwich and specialization. About 58 per cent feel that specialization alone is good enough even though sandwiching is desirable but sandwiching is not easily feasible. Almost everybody is against the idea of a very broad based education without sandwiching.

General Engineering and Consultants: Having discussed the question of feasibility of an ideal sandwich system, about 62 per cent hold that specialization is a must even though sandwiching is desirable.

Textiles and other Processing Industries: About 34 per cent of the respondents state that a system without sandwiching and without a narrow specilization is desirable. However, faculty development and curriculum development are held as very important. About 50 per cent of the replies support a moderately specialized sandwich system of education.

Electrical Industry: About 77 per cent support the idea of specialization with sandwiching indicating also that specialization should be according to needs and be gradually introduced.

Electronics Industry:—About 70 per sent support the idea of specialization an dsandwiching while, 80 per cent are in favour of specialization without sandwiching. Many consider sandwiching is very desirable since it helps candidates develop practical skills. Sponsoring from industries is held very desirable in such cases.

Overall Assessment:

The Summary of the views of all industries is given below:

Specialisation with sandwiching	66%
Specialization without sandwiching	52·5%
Sandwiching without spcialisation	44%
Neither sandwiching nor specialisation	17·5%*
Additional Post Academic Training	60%

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*Mainly from the process industries.

Special Suggestions:

A large number of replies contain the following opinions in addition to what has been referred to above.

1. Student selection should be based on sound aptitude tests.
2. Some training should be introduced in the high school stages to motivate and inspire students towards engineering and technology.
3. Certain subjects such as industrial hygiene and safety, industrial law, modern manufacturing methods etc. should be introduced.
4. The curriculum should be revised from time to time and experts from industry should take an active part in designing the curriculum wherever necessary.
5. The teachers should have a minimum prescribed industrial experience. They should also be trained from time to time during the term of their service to bring them into touch with the latest techniques.
6. A close coordination between industry and education should be established. It should not be thought that one draws too much on the other. They should work together in a spirit of fostering their common welfare.
7. Industry should sponsor candidates for sandwich courses and offer their full co-operation in running such courses.
8. "Compensation" or "Honorarium" should be paid to industries who spend much of their resources for taking part in joint programmes.
9. Certain specializations at the "post diploma level".
10. Control of intake into polytechnics is essential.
11. Additional training to improve communication skills is necessary.

5.2.2. Selection and Placement of Technicians

Qualities looked for while recruiting technicians

a. *Engineering Industries*: The qualities that these industries look for while recruiting technicians are listed below in the order of popularity.

Sl. No.	Qualities	Percentage of employers looking for this quality
1	Basic technical knowledge . . .	61%
2	Practical job knowledge and ability to apply .	55%
3	Personal qualities such as sincerity, obedience, good personality, diligence, intelligence, sense of responsibility interest in sports and extra-curricular activities . . .	48%
4	Leadership ability	40%
5	Systematic analytical ability of problems and situations	31%
6	Aptitude	21%
7	Communication skill . . .	14%
8	Ability to get along with people . .	7%
9	Willingness to work with his hands .	5%
10	Physical and mental health . . .	3%

b. *Process Industries*: The qualities that these industries look for while recruiting technicians are listed below in the order of popularity:

Sl. No.	Qualities	Percentage of Employers looking for this quality
1.	Practical job knowledge and ability to apply .	45%
2	Personal qualities such as sincerity, obedience, good personality, diligence, intelligence, sense of responsibility, interest in sports and extra-curricular activities . . .	44%
3	Basic technical knowledge . . .	40%
4	Leadership ability . .	34%
5	Aptitude	13%
6	Ability to get along with people .	13%
7	Systematic analytical ability of problems, situations	11%
8	Communication skill . . .	11%
9	Willingness to work with his hands .	6%
10	Willingness to work in shifts .	4%
11	Physical and mental health . . .	2%

It may be seen that the following are the first four preferred qualities with any employer, whether of Engineering Industry or of Process Industry:

1. Practical job knowledge and ability to apply.

2. Personal qualities such as sincerity, obedience, good personality, diligence, intelligence, sense of responsibility, interest in sports and extra curricular activities.

3. Basic technical knowledge.

4. Leadership ability.

Further the following qualities score almost "Cent percent" in the individual industries noted below:

Almost 100 per cent of the employers from Automobile Industry unanimously look for:

(a) practical job knowledge and ability to apply

(b) leadership ability

(c) basic technical knowledge

(d) personal qualities.

Almost 100 per cent of the employers from Electric Motors and Generators Industry unanimously look for:

Basic Technical knowledge

Almost 100 per cent of the employers from Electronics industry also unanimously look for:

Basic Technical Knoweldge

Almost 100 per cent of the employers from Aeronautics industry unanimously look for:

Practical job knowledge and ability to apply

Almost 100 per cent of the employers from Textile Industry unanimously look for:

Personal qualities such as sincerity, obedience, diligence, intelligence, good personality, sense of responsibility, interest in sports and extra curricular activities.

Almost 100 per cent of employers from Paper Industry also unanimously look for:

Personal qualities.

Almost 100 per cent of the employers from Cement Industry unanimously look for:

Practical job knowledge and ability to apply.

Criteria of Selection:

Engineering Industries: The methods of assessment adopted by employers in these industries while recruiting technicians are listed below in the order of popularity.

Sl. No.	Assessment method	Percentage of Employers using this method.
1	Interview	94%
2	Scrutiny of Academic Records .	46%
3	Written Test	20%
4	Practical Test	14%

Process Industries: The methods of asessment adopted by employers in these industries while recruiting technicians are listed below in the order of popularity:

Sl. No.	Assessment method	Percentage of Employers using this method.
1	Interview	96%
2	Scrutiny of Academic Records .	23%
3	Practical Test	23%
4	Written test	11%

The interview method is undoubtedly the most popular one in industries.

Conclusions:

While engineering industries assign the priority to "basic technical knowledge" and give a second place to "Practical job knowledge and ability to apply" the process industries give the first rank to "Practical job knowledge" and third rank to "Basic technical knowledge". Both industries assign a high order of importance to "personal qualities such as good personality, sincerity, obedience etc.". Similarly both industries consider "leadership quality" as the fourth in importance. Hence, besides imparting basic technical knowledge and practical job knowledge, development of personal qualities and leadership quality should occupy a paramount place in the aims and objectives of Polytechnic Education.

Strengthening of practical ability in subjets like Humanities and Industrial Management should be aimed at instead of mere theoretical knowledge in them.

"Communication skill", "Analytical ability", "Willingness to work with hands" and "ability to get along with people" are other important qualities demanded by the employers.

Thus a thoroughly practical bias in the course and personal qualities would be important assets for polytechnic pass-outs looking for jobs. These aspects should be borne in mind while restructuring the Polytechnic Education System.

5.2.3. On the Job Training to New Recruits

A majority of industries feel that however sound the system of education and training of diploma holders is, they are not likely to exactly fit into the needs of the actual work done in an industry. They realise that some kind of orientation and shop floor training have to be given before the newly recruited diploma holder to become fit to discharge his responsibilities as a technician. Realising the need for this orientation and training several industries have organised induction and training programmes. The pattern of the existing programmes is as given below:—

Three to four months only .	State Transport (Maharashtra) Some units concerned with Electronic Industry.
Total one year .	Heavy Machines Industry
Generally 6 months of shop floor work and 6 months of academic training) .	Railways, Tool Design, Electric Motors and Generators Petro-Chemicals.
Total 18 months .	Heavy Electricals
(Workshop practice (75% of the period) : Supervisory development, Job evaluation and work Study (for the remaining 25% of the period).	BEST Undertaking.
Total two years ; . (18 to 22 months of shop floor training and the reamining period as academic training)	Air Transport, Petro-Chemicals, Chemicals, Telephone industry, Tractors, Some of the non-ferrous industrial units.
Total two years : (General training in all shops for one year and a further one year specialised training for the particular job to be entrusted to him).	Textile Machinery Manufacture.
Total two years :	Tractors
(Training in the particular Department for which the technician is earmarked).	Some of the non-ferrous industrial units.
Training for three years (First six months in the training centre; Next 1 1/2 years training on the shop floor; Final year in shop supervision, Production engineering etc.)	Automobiles industry.
Training for three years in a particular Department.	Some of the non-ferrous industrial units.
Training for one to three years of which 3 months are spent on specific shop maintenance and 6 months in service section.	Bicycle Industry.
Training for 3 to 4 years (Mainly in drawing office)	Fabrication of Structural steel work.
Training for five years in a particular Department.	Some of the non-ferrous Industries.
No. specific period mentioned .	Some of the units concerned with Chemical industry.
No organised training programme.	Many units concerned with man-made Fibre industry, Iron and Steel industry, A few textile machinery manufacturers. Port Maintenance, Some units concerned with the Electronic industry.
	Some of the units concerned with Chemical industry.
	Some of the units concerned with Paper industry.

It will thus be seen that industries consider their own training programme as essential. The period of training depends entirely upon the nature of the industry.

5.2.4. Promotional Opportunities

The following is a summary of the replies received to the questions on whether opportunities exist in each organisation for technicians with diploma qualifications to get promoted as executives and managers.

Engineering Industries that is, those which work with metal)	Promotional opportunities exist in 90% of the industries
Process Industries (non-engineering)	In 91% of the industries promotional opportunities exist.

Regarding the basis of promotion, almost 91 per cent of the industries refer to "merit". Both experience and merit form the basis of promotion in 19 per cent of the engineering industries and 12 per cent of the non-engineering industries. A very négligible number (say one per cent) of the engineering idustries base their promotion on specific tests. The rest did not respond to this question.

The factors that are taken into account in judging merit are as below:

Engineering Industries

1. Periodical Merit Reviews
2. Personal Records or confidential reports
3. Ability to shoulder bigger responsibility
4. Rating the performance
5. Skill.
6. Performance in interview
7. Ability to control the personnel under him
8. Ability to interpret management's views properly to workmen.
9. Qualification equivalent to degree
10. Ability to organise his work.

11. Ability to get work done
12. Initiative
13. Ingenuity
14. Proven technical and supervisory ability
15. Ability to carry out managerial tasks.
16. General acceptability in the organization.

Process Industries

1. Job performance
2. Achievement resume
3. Efficiency.
4. Ability and judgment
5. Practical approach
6. Leadership quality
7. Initiative
8. Usefulness to the Company
9. Job knowledge
10. Skill
11. Potential
12. Ability to control and handle men.
13. Ability to exercise cost control.

It will be seen that promotions of technicians to higher levels is generally done on the basis of some definite criteria. The level upto which a technician can rise is not specified by a large number of respondents.

Some of the special comments received from industries on this subject are summarised below:

Respondents belonging to Engineering Industry

1. A proper proportion of higher level posts is available for diploma holders.
2. First preference will be given to degree holders before promoting technicians to higher posts.
3. There is no discrimination between diploma and degree holders in the matter of promotion.
4. Diploma holders with membership of the Chartered Engineering Institute are considered for promotion.

Respondents Belonging to the Process Industry

1. Fifty per cent of the higher level posts are filled up by promotions and the rest through advertisements.
2. Diploma holders should have membership of professional associations.
3. Equal chances are given for degree and diploma holders.
4. There is no fixed criteria for promotion.

ABSTRACTS OF OPINIONS OF SOME EXPERTS ON THE PROMOTIONAL OPPORTUNITIES:

1. *S. P. Chitnis, Chairman and Managing Director, Chitram and Co., (P) Ltd. Madras.*

"All the units that I had discussions with, agree that the technician can reach the highest post if his merit demands it and in all these units this principle is practised. His proven usefulness entitles him for the following promotions when vacancies arise:

> *At the works*: Senior, Technical Assistant Assistant Engineer, Superintendent of Sections, General Superintendent or Foreman, Works Manager. . .
>
> *At the office*: Senior Technical Assistant tant Engineer, Executive Engineer, Superintending Engineer, Chief Engineer.

The higher the technician rises in his profession, the more the responsibilities he takes and deals with more men. In this process his devotion to duties and the initiative he takes to get a job done well, make a big appeal to the management for improving his prospects. It is not seldom that the management finds itself unable to meet the claims for promotion only on grounds of seniority of service.

The question of promotion to the technicians or any other member of staff is therefore solved by selecting him who contributes most to meet these demands. Merit therefore is the main criterion or the basis on which promotions are to be given to the executives and is the basis on which the well-being of the industry is built."

2. *J. G. Parikh, Director, Silk and Art Silk Mills Research Association, Bombay.*

"It has been found in some of the Mills that there is a practice of getting technical work done by non-technical personnel, which at times, is presumably due to a shortage of technical personnel. This indicates that there are sufficient job opportunities for technicians. In many of the mills promotions are based mainly on job performance, practical approach, leadership and personality. Hence there are many promotional opportunities in mills for technicians with diploma qualifications."

3. *P. B. Adur, The Associated Cement Companies Ltd. Bombay.*

"A. C. C's future needs of technicians will mainly be of a replacement nature arising out of a turnover due to:

(a) Promotions, retirements and resignations.

(b) Progressive mechanisation of older units.

(c) *Adaptation to technological changes in the manufacturing process.*"

4. *G. K. Devarajulu, Chairman, Textile Machinery Development Council, Coimbatore.*

"In case of diploma holders, promotions are mainly based on their capacity to be useful to the organization. A diploma holder has a distinct disadvantage in the beginning of his career as compared with a degree holder. He has to prove himself in a large measure his capabilities, quality of leadership, independent thinking, acquirement of knowledge and practical experience and industriousness to make himself suitable for promotion. A company will only consider how much a person has an ultimae useful value and a diploma holder with the above mentioned diploma holders is small. It requires great effort and true evidence that the scope of promotion for a qualities is as good as anybody also. There is positive ecident that the scope of promotion for a diploma holders is small on requires great effort and exceptional abilities on the part of a diploma holder to secure a higher managerial cadre in a company."

5. *K. K. Nair-(Electronic Industry)*

"Promotional opportunities do exist in the industry for diploma holders based on experience and merit. In general a diploma with 4 to 5 years experience is equated to a fresh graduate in Engineering for purposes of promotion. Such an equation does not seem to exist (perhaps is not desirable also) in research organisations where diploma holders cannot ordinarily rise to officers' level. In order to enable them to have a quicker rise in the echelon, it is highly desirable to provide adequate facilities to professional examinations etc."

6. *K. Raghunathan (Electronic Industry)*

"Through departmental promotions and through direct recruitment procedures promotional opportunity is given."

7. *K. Sreenivasan, Director, South India Textile Research Association, Coimbatore.*

"Technicians should have adequate opportunities for promotion. In addition, opportunities should be provided to them so that the more ambitious and intellectual ones may be enabled to take external examinations such as associateships or fellowships of professional bodies so that they can rise to still higher positions. Promotions in the lower levels should be on the basis of merit-*cum*-seniority. At the highest levels it should only be on merit."

OPINIONS FROM INDUSTRIALISTS

1. *Engineering—(Textile Machinery)*

"In our organization, the promotion to the technician is by and large based on his capacity to be useful to the company. While considering suitability for promotion, his quality of leadership, independent thinking and his ability to get along with others become major factors. We prefer to promote our employees to higher posts than recruit from external sources.

On the basis of the past performance, devotion to the organization, capacity for hard work, willingness to work anywhere any time, executive ability to take work out of juniors and team work with equals and keeping in mind that promotion does not transfer the employee from his degree of competence to a degree of incompetence, opportunities are offered, beginning with supervisors, after 5 to 7 years they are promoted as managerial engineers and top executives."

2. *Aluminium and Coal Industries*

NCDC reserves 33 per cent for promotion to the posts of officers from among these technicians and this promotion is made on the basis of their performance of the job, their annual confidential character rolls and seniority in service. These are dealt with by a departmental promotion committee consisting of three or four top executives including the personnel manager.

In the Aluminium and Alloy industries and other small concerns, the promotion is based mainly on their performance which is judged by whether they can deliver the goods irrespective of their seniority.

3. *Yamuna Valley Development Organization*

Diploma holders with 10 years service become eligible for appearing to a qualifying examination for promotion as assistant engineers. Promotion is made on basis of merit in the qualifying examinations. 20 per cent quota of Assistant Engineers is reserved for promotees. Thereafter, promotion as executive engineers and superintending engineers is made on basis of merit-*cum*-seniority in the cadre.

4. *Small Scale Industries*

It is generally reported that since they have started their industry very recently, they are not in a position to evolve any definite pattern for promotions. Opportunities are however available in their industry for diploma holders and they can come up as supervisory staff on the basis of their experience and merit.

5. *Not Classified*

Promotional opportunities are available for Diploma holders and their promotions are based on their knowledge of machines, materials and individual talents. Other unclassified industries with the exception of 3 industries reported that they are having promotion opportunities and a Diploma holder can come up to the level of a middle Manager. All of their promotions are based on seniority, ability to handle human relations and efficiency.

5.2.5. *Retraining of Technicians*

Respondents were requested to state if they have plans to retrain their technicians in order to meet their future technological needs. If so they were requested to indicate the areas of such retraining. They were further requested to state if they would desire that technical institutions where facilities are available could undertake this retraining work in the form of refresher courses.

Industries not in favour of Retraining Technicians:

Man made Fibre Industry: The man-made fibre industry does not have any plans for retraining their technicians at present nor do they think that this is necessary. A majority of the mills have arrangements under which they hold frequent meetings between departmental heads and technicians to solve job/product difficulties. They also depute their technical personnel to some of the short courses conducted by the Silk and Art Silk Manufacturing Industry Research Association (SASMIRA) Bombay.

Aeronautics Industry: It has been pointed out that the future technological needs of the aerospace industry cannot be met merely by retraining diploma holders, and that this need can be more easily met by engineering degree holders after some in-plant/on the-job training.

The Electricity supply and distribution organizations like Kumbakonam Electric Supply Corporation, Vellore Electric Supply Corporation, the Erode Electric Supply Corporation etc. feel that there is no need to retrain their technicians.

A Rayon manufacturing firm and a synthetic gem manufacturing firm, and a paper mill feel that periodical re-training for their technicians is not very essential since there are not many changes in the methods and the processes used in their industries. The Central Coal Washing Corporation, Omega Insulated Cables Manufacturing Company, Industrial Chemicals and few Cement Manufacturing Firms also feel the same way.

Shri K. Sreenivasan, Director of SITRA in his special memorandum has stated that retraining of Technicians is necessary in the Textile Manufacturing Industry whenever new machines are installed and new processes are adopted. The Fertiliser Corporation also feels the same way.

All other industries consider that retraining of technicians is necessary to keep in touch with the latest technological developments. Some of them do not have facilities for such retraining at present.

Providing Retraining at Technical Institutions

On behalf of the automobile industry it has been stated that it would be quite useful if technical institutions can provide retraining facilities "with proper co-ordination from industry". Some of the units belonging to the Iron and Steel Industry feel in the same way. The Civil and Structural Industry is in favour of Technical institutions providing retraining facilities.

One cement manufacturing firm feels that technical institutions can provide training; but that this should be supplemented by in-plant training with suppliers of sophisticated machinery.

The bicycle industry is of the view that in Company training can be supplemented or supported by training in technical institutions which are equipped to undertake it.

On the other hand the Textile Machinery Manufacturing Industry considers that retraining in Technical Institutions, of technicians belonging to manufacturing companies may not serve any useful purpose.

Retraining by Industries themselves

A large majority of the industries consider that industries alone should retrain their technicians. Some of their typical comments are reproduced below:

Bicycle Industry: Institutions are not expected to have the required facilities.

Electric Motors and Generators: Training is given by our Principals in Germany.

Heavy Industries: Such retraining should be given by the industry itself.

Heavy Electricals: Retraining is done on the job when technological changes are necessary. It is difficult to arrange such training in selected technical institutions as the training needs will be specific to each industry.

Chemical Industry: It is not essential for post academic specialisation to be conducted by the polytechnics because almost in all cases the subsequent employer will train the "raw material" and mould him as required by the organization.

Railways: Give refresher training to their technicians at all levels in their own workshops. They have the necessary facilities for that. Their duration of training is 6 to 8 weeks.

Port Trust: Technicians were retrained with the representatives of Manufacturers and Consulting Engineers.

Most of the industrialists feel that training of their technicians should preferably be in their own workshops. However, refresher courses and re-training in advanced methods may be offered in specialised institutions in an industrial atmosphere if such facilities exist there.

Petro-Chemical Industry: Have their own training officers. They have their own training centres except for computer course, net work analysis course industrial engineering etc. For these, the company uses facilities available in outside institutions.

Textile Machine Manufacturing Industry: If there could be interaction between Companies technicians could be sent for short duration to factories where more modern equipments and better production systems exist.

Facilities provided by other organisations:

By and large, several industries send their technicians for special short term courses run by professional associations such as the Productivity Councils, Management Associations, the Indian Statistical Institute, NITIE etc.

One of the leading Civil Engineering construction firms points out that many of the diploma holders may like to prepare for Sections A and B Examinations of the Institution of Engineers (India) and that, therefore, it will be of great assistance to the diploma holders if the Institution of Engineers arranges refresher courses in collaboration with the Universities and engineering colleges.

The National Institute of Foundry and Forge Technology, Ranchi has already organised 2 to 3 months short term refresher courses for persons at the supervisory level in the fields of Foundry and Forge Technology. For admission to these courses, the minimum qualification is Diploma in Engineering (Mechanical, Metallurgy or equivalent) with 2-3 years experience in the particular field. Preference is given to candidates sponsored by industry. A long term industrially oriented course at the Supervisory level in the fields of Foundry and Forge Technology is also proposed to be started. All these courses are of sepciailsed nature and higher than diploma level.

Other Methods of Retraining Technicians:

One of the experts connected with the Textile Machinery Manufacturing Industry observes as follows:

> "We believe that once a technically qualified person has entered the industry, at no stage his training ends. In our organization, he is given every opportunity to advance his knowledge and experience. Technical Magazines, books and other materials are readily available to him. On many occasions, the top management marks the articles and write-ups in technical magazines to be read by the technical personnel. Each of our technicians is given an opportunity to travel within the country on one job or the other. During these travels, he comes into contact with other technical personnel and indulges in technical discussions which are very beneficial. A professional man cannot permit himself to be static and stagnant. We are of the opinion that this aspect is not adequately emphasized during his academic training.
>
> Whenever certain special training was found necessary, we have deputed our technicians to attend specialised courses. The results have been satisfactory. Participation in Seminars and discussions and work in workshops of similarly employed technicians also help. It is our observation that students who have developed the capacity to think and have the curiosity to know, have been most successful as technicians. Unfortunately, in our experience there have been very few students possessing these qualities. Many more students can develop these qualities if given opportunities while being trained in an institution."

A leading electrical engineering firm with its principals in U.K. informs that re-training, if found necessary for their technicians, is given in the workshops of their principals in U.K.

Area of Retraining

The areas of retraining suggested by respondents are listed below:

Area of Retraiding	*Suggeste by*
Industrial Belectronics	Iron and Steel Industry
Operations Research	Cement Industry
Instrumentation	Petro-Chemicals, Iron and Stee l Industry, Cement Industries
Tooling and Tool Room Practice	Bicycle industry
Tool Design	Textile Machinery Indust
Tool Engineering	Machine Tool Industry
Workshop Engineering, Machine Design and Drawing	Paper Indutry, Textile Machinery, Automobile Industry.
Production Engineering	Automobile Industry
Plant Operations	Petro Chemicals
Production Planning	Iron and Steel Industry Textile Machinery Industr Electronics Industry

Production Control	Textile Machinery Industry Electronics Industry
Process Control	Iron and Steel Industry
Dry Process Operation	Cement Industry
Metallurgy	Telephone Industry
Testing	Electronics Industry
Standardization	Automobile Industry
Materials Control	Automobile Industry Electronics Industry
Quality Control	Iron and Steel Industry Automobile Industry Electronics Industry Eelectric Motors and Generators Industry
Preventive Maintenance	Petro Chemicals,Paper Industry Iron and Steel Industry Automobile Industry Electronics Industry Textile Manufacture Industry Rolling Mills
Tool Room Practices	Machine Tool Industry
Power Plant Engineering	Paper Industry
Industrial Engineering	Paper Industry Iron and Steel Industry
Special purpose Machines	Bicycle Manufacturing Industry
Pump Design	Pump Industry
Foundry Technology	Foundry and allied Industries
Production and Metallurgical Inspection	
Sheet Moulding, Die Casting	
Industrial Organization and Management	Telephone Industry
Supervisory Courses	Railways, Telephone Industry Automobile Industry Electric Motors and Generators
Method Study	Railways
Work Study	Railways, Iron and Steel Industry Automobile Industry Electric Motors and Generators and Pump Industry
Time and Motion Study	Textile Machinery Industry
Factory Law	Telephone Industry
Simple Factory costing	Telephone Industry
Sales and Servicing	Electronics Industry
Spinning and Processing	Textile Machinery Industry
Paper Technology, Chemistry and Engineering	Paper Industry
Advanced Studies of Design of Structures	Structural Engineering Research Institute

5.2.6. *Industrial Training for Technical Teachers*:

All agree that technical teachers should be uptodate in their knowledge of the practices of industries and should be able to enlighten the students with the latest methods and techniques adopted in the industries. But when it comes to the question of providing training facilities in one's own factory to the polytechnic teachers, opinion is divided.

Seven firms only replied that they are already giving training to teachers from Technical Institutions (Iron and Steel Industry, Textile Industry, Port Works, an electrical engineering firm and a civil engineering firm and a firm manufacturing automobiles).

Nearly 80 per cent of the respondents stated that they are willing to offer training to staff of Technical Institutions, but had so far not trained any, because they were not approached by any institution.

A textile firm is willing to train teachers on an experiment basis if teachers are sent in small batches. The Central Coal Workers Organization wants to offer training to the teachers and simultaneously use the teachers to train their technicians in their shop floor when the teacher is with them. A cement manufacturing company is willing to offer training facilities to teachers provided they are prepared to work with their own hands.

It is stated that a policy decision by Government or other higher authorities is necessary before some of the Public Sector Institutions like Railway Workshops, could arrange to take in technical teachers for training. One respondent has stated that the Tamil Nadu Government is following a procedure of transferring teachers to the PWD and Industries Department and *vice-versa*. It is felt that this is not being practised widely at junior levels.

Most of the private sector top executives feel that it is very essential that the polytechnic teacher should get the industrial training, but some of them say that they will not be able to take up this work because of the small size of their units. One opinion is that industries will agree to train teachers subject to the provision that the teachers are not inquisitive to know technical secrets of the firm. An oil Refinery firm has stated that it will not give training to teachers since it wants to safeguard technical secrets. A chemical firm has stated that it has a technical secrecy agreement with its collaborator and hence it is not possible to offer training, to non-employees.

On the question of payment to the teacher trainee, it is stated that the institute should pay the teacher during the training period. One firm is willing to provide facilities if it does not cost them anything. It is not willing to pay any stipend to the teacher trainees. Another firm does not want to take the responsibility of training or educating the teacher. It has stated that, "nobody gives training for somebody who will not be of any further direct use immediately."

One respondent replies that they will allow teachers to visit their factory along with the students and another firm has stated that teachers, while in training should learn by actual practice and not by mere observation. "Apart from working in a factory for sometime, teachers should visit more-factories along with students when they go on tour to learn latest methods", is yet another suggestion. One heavy engineering factory writes to say that it will permit teachers to visit and observe for a short period in their production units.

No uniform suggestion has been made about the duration of the training, a Polytechnic teacher should have. It ragues from one month to 5 years at a time. One suggestion is that the teachers should be made to remain in the industry for a fairly long period with specific responsibilities. A training period of one year is recommended in one case. Three to four months training for every teacher, in alternate year is another suggestion. A minimum training period of 6 months has been suggested in another case. It is also suggested that only persons with 5 years industrial experience should be recruited as polytechnic teachers. This apparently means that the industries should not be saddled with the responsibility of training a teacher any further. Almost all agree that industrial training is a necessary prerequisite for taking up a teaching job in a technical institution. Some say a period of 3 years and a few 5 years should be spent on the floor of the Workshop before coming to the class room to teach. There was also a reply from one firm which would insist on a practical experience of 10 years for every polytechnic teacher, 6 years in the floor as a technician and 4 years as a leading man in the middle or top level of management. A paper mill prefers that people with 10 to 15 years experience in responsible positions in industry should become teachers, but states that *Vice-Versa* is not advisable.

A teacher should have industrial training not only before he becomes a teacher but also during his tenure as a teacher—is the opinion expressed by many. Such training during the tenure of his work as a teacher may be of short durations extending from a few days to 3 months, during summer vacation. Some suggest that such training should be given compulsorily for all the teachers during vacations for a period of 2 months, under well programmed conditions and increments and promotions should be linked with such training. The Director of SITRA, Shri K. Sreenivasan suggests that teachers should be placed in responsible positions in Industry to make them effective teachers. Industrial training should be for 3 months at intervals of 5 years for every teacher. Another suggestion is that teachers should go to industry for a period of one year once in every 5 years.

In a very comprehensive report the Chief Engineer of a Civil Engineering Company has suggested that technical teachers should be encouraged to write textbooks in their fields and that teachers should follow-up the students during their industrial apprenticeship, and keep track of their further positions in industry. He suggests also a code of conduct to be evolved for technical teachers and enforced.

The opinions of the top management personnel in the Textile Manufacturing industry regarding teacher training are as follows:

The teachers in polytechnics are often fresh graduates who consider polytechnic education as a diluted engineering degree education and they need to be educated on the aims of polytechnic education. Polytechnic education is going down in standards due to lack of trained teachers. Their knowledge is bookish and out-dated. Teachers should be encouraged to write text-books. They should spend 2 months every year in industry. The industry will give training to teachers in limited areas for shorter durations.

Most of the artificial fibre manufacturing units are not willing to offer training facilities to teachers because they say their units are small in size and they expect bigger units to do this job.

The response from petro-chemical industry to train teachers also is not very encouraging even though most of them say that such a training is highly essential.

The experts from the electronic industry feel that training for teachers is more essential than for students and they suggest that the Quality Improvement Scheme of the Union Ministry may be adopted. They feel that the training for 6 months in Industry will be useful to teachers.

An expert from the automobile industry expressed an opinion that sufficient incentives should be given to teachers to attract the best talent to the teaching profession.

The top management of a textile machinery manufacturing industry stated that teachers do not have any industrial background and they lack a knownledge of principles of management productivity, safety, house-keeping etc.

An eminent person from the Railway states thus "Teachers in Polytechnics are often second rate persons who entered institutions through political pressures, nepotism etc. This state of affairs should change. Higher scales of pay should be offered to attract the best talent. Teachers should undergo training in summer, instead of wasting their vacation in evaluating examination papers for which they get some remuneration. Consultancy should be encouraged."

A Government Polytechnic Principal has suggested that test standards and curriculum should be reorganised such that the teachers feel that unless they have some industrial training they will not be able to pull with the profession. Educational Testing Laboratories should be set up, which should evolve the types of questions to be asked in examinations etc.

Apart from stressing the importance of Industrial training for Polytechnic teachers, quite a few respondents mentioned that Polytechnic teachers should also be trained in the methods of educational psychology as well. It was stated that one year training in Educational Psychology in Technical Teacher Training Institutes and one year training in industry should be insisted upon before appointment as teachers. One more suggestion was that Polytechnic teachers should have sandwich training in industry and short term summer courses in teaching methods. 'Training in Teacher Training Colleges is more essential than Industrial Training'—reports a leading electrical engineering firm.

However, the reply from another leading electrical engineering firm on the question of teacher training in industries is rather unusual. It states "The teachers are acquiring industrial experience and whether it would be particularly useful to them in the discharge of their duties as technical teachers is seriously doubted unless the quality and calibre of the teacher is of a high level. Industrial experience is hardly of any use. We should be sure what sort of experience is to be picked up by teachers from industry and imparted to students. However as an experiemental basis teacher training in industries may be tried."

5.2.7. *Co-operation from Industry*:

Industries were requested to state if they are in a position to provide the following assistance to polyechnics in order to enable them to turn out technicians suitable to industries,

(1) Supervised training of the students in specific fields of specialisation and,

(2) Making available their senior engineers and technicians to give a course of lectures on specialised topics to the final year students of the polytechnics.

From the replies to the questionnaire, it is found that:

(1) many industrial units agree to offer supervised training to polytechnic students.

(2) Some industries are willing to offer training facilities to students of Polytechnic under their own supervision, subject to certain conditions

(3) A few industries have their own reasons to say that they will not be in a position to offer supervised training.

The following industries are willing to offer supervised training to polytechnic students in their shop floors without any reservations:

(1) Machine Tool Industry;

(2) Paper Industry;

(3) Electric Motors and Generators manufacturing industry.

(4) Non-ferrous metallurgical industry;

and

(5) The Cotton Textile Manufacturing Industry.

The following industries have stated that they would be willing to offer practical training facilities subject to certain conditions:

(1) Railway workshops;

(2) Heavy Electricals;

(3) Heavy Engineering Industry;

(4) Textile Machinery Manufacturing Industry;

(5) Electronic Industry;

and

(6) Many Small Scale Industries.

The conditions stipulated were:

1. The industry will not incur any expenditure in allowing the students to work and get trained in their shops.
2. The losses to the factory by way of materials wasted by the trainees should be made good.
3. They will not be in a position to spare their officers to plan and supervise the training.
4. The candidates trained in their workshops should be willing to get employed in their own factories and not migrate to the works of their potential competitors.
5. In case the trainees meet with any accident during the period of training, no compensation will be paid to them by the factory.
6. The trainees should strictly observe the rules and regualtions of the company and take to training in a serious attitude rather than with the aim of just getting a certificate.
7. **During the entire period of training, the teachers from the college should be in close touch with the trainees and be guiding them properly.**

The aeronautics industry stated that training in their workshops will not generally benefit a polytechnic student unless he is to be employed in their own units. But the possibilities of polytechnic students acquiring the posts of technicians in the aeronautical industry are rare. The industry requires very high standards and prefers to take in technical graduates and hence regrets its inability to be of any help in offering practical training to polytechnic tudents.

Some of the industrial units doing specialized jobs expressed that instead of getting trained in their shops, if the candidates came to them after being trained in some general purpose workshops, it would be more useful to the candidates.

Regarding the sparing of the services of some of their senior staff members for lecturing to the final year students, almost all the respondents welcomed the idea. It was reported that the top management will not stand in the way, if the senior engineers volunteered to give special lectures. Some stated that whenever such works are undertaken by their engineers, they should be duly paid by the colleges. It was also stated that if the lecturing in polytechnics were to be arranged after the work hours they won't have any objection to spare the services.

5.3. Some Specific Observations on Issues not Covered by the Questionnaire.

A few respondents have sent their detailed suggestions on some aspects of training and placement of polytechnic candidates not covered in the questionnaire as summarised below.

5.3.1. Deficiencies in Diploma Holders:

The technicians who are supposed to have the ability to comprehend scientific and management theories should have high degree of specialization in the particular skill and good insight in identifying and solving job problems. In addition to this they should be in a position to understand the instructions given by engineers and to express them clearly and unmistakably to the craftsmen who are actual operatives working in the shop floors. This calls for genuine aptitude for technical jobs, ability to understand technical details and communication skills.

But the present system of Polytechnic education has failed to fulfil the above requirements.

At present, the diploma holders are

—ignorant of the actual requirements of industry due to the lack of industrial experience.

—poorly equipped with technical knowledge.

—confused about their position in industry.

—finding a big gap between what they are taught and what they have to perform.

—functioning more or less as technical assistants doing semi-technical and semi-clerical jobs.

—without any sound footing in areas like technical report writing and human relations.

The polytechnic course is a very poor and diluted version of the degree course. The diploma course does not provide for any depth of knowledge.

Except for every rare exceptions, most of the applicants seeking jobs do not seem to possess the requisite engineering background to understand what is expected to them. They lack self-confidence. Uncertainty and confusion upset their performance in the interviews for want of adequate grasp of engineering principles. Both in the oral and written tests conducted in the elements of applied engineering to measure the knowledge and aptitude of the applicants for the subject, their responses are poor.

5.3.2. Pattern of Polytechnic Education

Vocational Training at High School Level·

Vocational training should be offered to high school students as a first step in the engineering education. This training will help a student to make his own assessment of his aptitude to the subject and will help him to develop a proper attitude. Workshops of Industrial Training Institutes may be used for such training.

Uniformity in the System of Technical Education:

A uniform course of instruction for technicians in all institutions in India should be prepared in consulation with Universities, Engineering Societies and Industries. All institutions should be persuaded to follow the recommended curriculum. The duration of the course should be three years. There should not be any difference in attainments of technical personnel of different Institutions in India.

Meeting Specific Needs of Industry by Diversified Courses·

Technicians Training Programmes should impart adeout for about 12 or 15 different branches of technology and industries could pick up suitable candidates trained in any one of the branches and give them on the spot training to make them useful for their production programmes. What is necessary is that the Technicians Training Programmes should impart adequate knowledge in the chosen field of technology and acquaint the trainee with the practical skills involved in that particular speciality.

Pattern of Courses

Sandwich training appears to be well suited for keeping the diploma education industry oriented. This is easily done if each polytechnic could be attached to an industry or a group of industries. They may be asked to share the burden of finance, equipment and staff. The Government may arrange to give buildings and equipment. But this method disfavours the practice of establishing polytechnics in rural areas. An alternate method would be to recruit candidates who have worked in the industry for one or two years and who are sponsored by it. The industry may release them from work for the required period. Yet another possibility is to run the polytechnic as an evening course so that persons who are employed in the industry (those who have completed apprenticeship course and put in 2 to 3 years of practical work) can be selected for the course. The merits of the above methods may be considered and an appropriate method may be chosen for a particular area.

Need for Continuous Review

Because of the dynamic technological and scientific changes taking place the provision for constant review and up-dating of course content, and teaching and training programmes must be ensured.

5.3.3. **Intake, Admission, Curriculum, Syllabus etc.**

Reduction in Intake

Since there is unemployment problem among technicians and engineers it is widely felt that the intake should not be increased further for some more years.

Future intake capacity should be decided on the basis of future requirements of industry.

Entrance Requirements

The various suggestions received are:

1. The duration of the course should be three years and minimum educational qualification for admission should be atleast Higher Secondary Course with Physics, Chemistry and Mathematics.

Girls should be able to enter technicians training course on precisely the same conditions as boys and should be given encouragement to do so in certain branches of engineering. Selection of candidates of either sex should be based on inclination, aptitude, ability and minimum basic qualification *i.e.* all technicians' training should be open to boys and girls and selection of rejection of an application should be determined by tests of inclination, aptitude, ability and by basic qualification.

2. Many students join the technical courses not because of any real interest in them but because they failed to get University courses or due to economic circumstances. Only persons having aptitude for engineering should be selected (by suitable selection procedure) and the number should be restricted.

3. Admissions into polytechnics are to be given to only those who have a minimum two years of practical experience in their subject of interest. This practical experience could be widened if the students are sent to specific industries to work during their vacation periods. Facilities for this should be arranged by the institutes and they should ensure that the candidates are introduced into the real working of the industry and made to work by themselves and not observe others working.

Post-academic training by the employer need not be a MUST. This could very well be avoided if the polytechnics could give the students intensive theoretical-*cum*-practical education.

4. Selection of students to technical institutions should be based on the capacity for practical thinking, analytical approach to problems and the mental aptitude towards engineering subjects. It is necessary that the students must know English language which alone would provide them immense opportunities to learn about the rapid technological advances made in the world from the vast treasure of books and journals published.

Uniform date for commencement of courses

The admission should be in January and final examination results should be declared by mid-December. There should be only one vacation and that should be in summer.

Curriculum

The general programme of study, namely, the number of subjects and the number of lectures per week should be so arranged that the students have adequate time to absorb what they learn in the classroom.

A judicious balance has to be maintained between theoretical instructions and practical work to sustain the interest of the trainees in their studies. Project work on group or individual basis should be encouraged in which the teachers should actively participate.

Modification of Syllabus

The students in Polytechnics are now taught too many subjects simultaneously. As a result they are unable to do full justice to all these subjects and they get only a shallow knowledge in the subjects taught to them.

This can be improved by branching out the subjects i.e. by making some basic subjects compulsory to all branches of students and when the students branch off to their particular course of study by making a few core subjects only compulsory and by introducing others as optional subjects.

5.3.4. **Teaching and Examinations**

Teaching of Related Subjects

Young technicians are expected to perform a wide range of professional duties and therefore it is essential that they should have some knowledge of the basic sciences and essentials of other subjects such as economics, management sciences, factory organisation, personnel management etc. because they have to work with skilled and unskilled labourers, equals and superiors.

Preparation and sale of Textbooks

Textbooks on engineering subjects, should be prepared by the University professors and they should be sold at concessional rates to the students. The standard engineering textbooks are very costly except for the low priced editions of text-books of foreign authors which are now published in India. A few chosen professors and industrial experts may be encouraged to write text-books by offering cash rewards. There are obvious educational advantages in having text-books specially written by experienced teachers to suit the local conditions.

Supply of Class Notes

The students normally take down lecture notes but it is difficult and time consuming to copy down sketches and drawings from the black board. As the number of students is large and the subject matter repetitive for new batches of students, it is suggested that the notes and sketches be duplicated (cyclostyled, blueprinted etc.) and distributed to students to save time. More attention may be paid for discussions based on the notes.

Use of Models and Films, Visit to Projects etc.

For civil engineering students, some models of the bridges, transmission towers etc. can be prepared. Industrial tours or visits to big projects under construction should be arranged.

Best results will be derived if the students are taught with film strips in such topics as the fabrication of steel structures, construction of roads and buildings etc. The students will learn best if they are frequently taken to workshops and factories and worksites to observe how machines are operated, how different jobs are done etc.

Building up Initiative

Too much stress is laid on students passing the examinations rather than the understanding of the subjects. Capacity for independent study and tackling problems in practical situations must be developed. Industry prefers persons who rely on their own resources and use their commonsense, analytical ability and judgement.

Developing Communications Skills

Lecture meetings or seminars should be organised so as to develop their powers of expression and ability to solve problems through group effort. To develop self-confidence in the students there should be a practical course of one hour per week for discussion among students. As many students as possible should be encouraged to participate in debates on special subjects of interest. They should also be assisted by their teachers to contribute articles to the college magazines and prizes may be awarded annually for the best performance.

Library and Workshop Facilities

Library facilities should be improved and many new books and journals must be added every year. The reading room may be kept open for long hours for the benefit of the students and the teachers. If it is possible, the reading rooms must be air-conditioned. Workshop facilities should be improved and students must be encouraged to prepare, design and manufacture a working model such as fan, motor, engine, pump etc. with the help of their teachers.

Publication of Project Reports

The reports of the big engineering projects in our country should be published with all details and with information on the design, calculation, construction details with cost estimates for the benefit of young engineers, so that they can gather more quickly from the experience of others the knowledge as to what to avoid and what limitations should be kept in mind to prepare safe, sound and economical engineering projects. These engineering reports should be published by the Government of India, Ministry of Education and made available at concessional rates to all as done in the U.S.A. by the Tennessee Valley Authority.

Special Lectures by Experts from Industry

Experts from the industry may also be invited occasionally to speak to the students.

Arrangements must be made for weekly lectures in all subjects by experts in the various fields drawn from the industry.

An interaction between the Industry and the Faculty is what is very badly needed today. This can be achieved by inviting persons from the industry as honorary or part-time lecturers in technical institutions particularly polytechnics. Such special lectures from them could form part of the regular syllabus and can be classified under 'Lectures on practical aspects'. These lectures could be given twice in a week on selected subjects depending upon the course. In the case of Civil Engineering, Electrical Engineering or Highway Engineering the technical officers from the respective Departments like the P.W.D., Electricity Board and Highways could also be invited to be part-time lecturers for such practical lectures. In fact in Mysore State, this has been practised and has proved very successful. The professors or lecturers for electrical engineering, civil engineering or even mechanical engineering of Government Colleges of Engineering are sometimes being drafted on a deputation basis from the P.W.D. Electricity Board etc. so that their teaching will be a well-balanced and judicious blend of both theory and practice.

Examination System

The system of one examination at the end of each year should be replaced and the semester system may be introduced. More attention should be paid to project work, tutorials and homework, marks awarded to project work and homework and class participation be taken into consideration while declaring the final results.

Importance must be given and more marks allotted for their day-to-day class work and sessional work than for the tests in any subject. According to the prevailing system, every student is examined twice in some subjects, once in the second year annual examination and once again in the third year final examination. This system should be abolished. Syllabus of some subjects must be completed in the second year class and final examination in these subjects must be held in the second year so that in the third year, for the final examination, students will not be overburdened by many subjects.

Question papers must be set and answer papers evaluated by the teachers who teach the subjects.

A student's performance in the final examination does not indicate in any fair measure of reliability his competence in that subject. The other factor such as the liberal attitude taken in evaluating his performance in the final examination and the moderation shown subsequently may make the evaluation unreliable.

The emphasis should be shifted from the annual examination to his total perfarmance during his period of study in the institute.

5.3.5. Teachers and Faculty Development

Recruitment of Teachers

A polytechnic is as good as its staff. At present talented and competent people are not attracted to the teaching profession due to the poor , salaries and grades offered, with the result that the quality of teaching is poor. The first problem to be tackled therefore, is to build up a cadre of really competent teachers through attractive salaries and grades.

Emoluments of Teachers

This should at least be on a par with that in industry so that a person can migrate from industry to the teaching profession without much financial loss.

Faculty Development

The present day teacher is devoid of practical experience and his methods of teaching and training of the students do not contribute to the development of and acquisition of skills required. There has been too much stress on theoretical education with little emphasis on practical aspects. The teacher is not exposed to problems of industry pertaining to management, productivity and advancing technology.

Training of teachers is one of the most important and vital matters to be taken up by the institutions and the Government. The faculty members should be allowed to work in an industry for a period of one year once in every five years. Teachers must have industrial training to keep themselves aware of industrial practices and thereby make themselves more effective and purposeful in teaching. The gap between industry and technical education should be filled up by taking prominent technical personnel from industry as faculty members for certain periods. Seminars can be organised in which teachers, students and experienced technical personnel from industry can participate and discuss. Industries may also sponsor research programmes with institutions for mutual benefit.

At present, even fresh graduates coming out of the Engineering Colleges without any experience are appointed as lecturer. It is necessary that before such graduates are employed, they have atleast 3 years of practical experience in either industry or some Governrment Engineering Organization. This apart, every third year there should be a Refresher Training Programme so that teachers in ploytechnics are exposed to the problems of the industry in an intensive manner. All this means that the industry and educational institutions have to get together in planning polytechnic Teacher Training Programmes.

One of the objectives of training of technicians is to prepare them eventually for industrial life. It would be advisable therefore that a teacher should visit periodically such establishments where these technicians are taken for training so that any lacunae in their practical training can be removed.

It is an excellent idea if teachers spent some time *i.e.* 3 to 4 months every alternate year in big design offices and factories and at construction sites of big projects. This will keep them in touch with some of the practical problems which will have to be tackled by the technicians when they enter employment after leaving the institutions.

Industrial experience may be made compulsory for all teachers employed in technical institutions. An approach may be made by the Government to those industrial houses who would be willing to allow their employees to be seconded to teaching establishments and *vice-versa*

Code of Conduct for Teachers and Students

Students very often complain that the teachers do not take their classes regularly and seriously. These complaints need to be investigated and a code of conduct for teachers formulated and guidelines for improving standards of teaching to be evolved. At the same time to emphasise student discipline and to ensure serious application to studies, a code of discipline for students is necessary.

5.3.6. Practical Training

Responsibility of Industry

Technical education should be formulated and organised with the active cooperation and participation of industries. Industries have a major responsibility in the task of integrating theoretical learning with practical industrial experience in cooperation with the educational institutions and Government. The task is of great national importance as it involves the development of technical manpower for Research, in Design and Development, in Management and in various other engineering fields.

Practical Training

The importance of industrial training at shop level as an integral part of the technicians' training need hardly be emphasised. Not only proper arrangements need to be made for their on-the-job training in industrial engineering establishments, but there should be proper supervision and follow up by the teachers to ensure that they receive the appropriate training during the period of training.

A planned programme of vacation practical training in industry supervised or inspected by the teachers is to be arranged.

At present only about one per cent of successful candidates get proper practical training. Arrangements must be made by the Government so that all outgoing students get compulsory practical training atleast for six months with stipend from Government Each and every technical institution must have a production factory attached to it financed either by the Central or State Government. This will not only help to render practical training to students but also will provide opportunity to poor students to earn while they learn. In addition to this, arrangements should be made for vacation training of the students in industrial organisations.

Sandwich Training

The sandwich courses aim at a meaningful education by blending theory and practice. Such courses are popular in U.S.A., Germany and U.K. For organising such courses cooperation of industry is essential to look after the practical aspect of education.

Sandwich courses are preferable, especially for the specailzed courses, as they will result in a reduction in the time that it now takes for a student to go through his academic and practical training. In other words, he will be available for shouldering job responsibilities within a shorter period of time. Existing industrial establishments may not, however, be able to provide practical training facilities to all students. It may therefore be necessary, in the first instance, to restrict Sandwich Courses to those undergoing specialized training and such vacancies should be determined by Government on a State-wise basis in consultation with industry.

Course of sandwich type 'in-plant training' should be introduced where a student is able to work in industry for a period during his education. The main objective of sandwich course is to integrate engineering education with practical experience, during the period of study in order to enable the student to gain experience, insight to industry and self-confidence.

Industries should actively participate in this sandwich training programme. This programme should be carried out with the guided supervision and a proper evaluation of work done should be made during the course of training. The duration of industrial training should be at least 12 months, divided into two or three convenient parts.

5.3.7. **Placement and Specialisation**

Appointment of Standing Manpower Committee

The present day student unrest is perhaps mostly due to unemployment problem in addition to economic and sociological problems. The whole task of reorientation and modernisation of courses will be fruitless, unless the diploma holders are given suitable jobs soon after completion of their studies and practical training. This is the responsibilty of the Government.

A committee is to be set up to forecast manpower requirements in different fields for various industries. Such forecast will help the organisation of new courses from time to time and also will reduce the imbalance of demand and supply of technical power.

Selection and Placement

The following factors should be taken into account while recruiting a technician:

1. General and academic qualification.
2. Previous practical experience including training.
3. Capacity to analyse a problem and apply his mind constructively.
4. Ability to read drawings.
5. Personality, knowledge of English, ability and ingenuity.

and

6. Behavioural aptitude (of cooperation and collaboration with colleagues).

The first two items may be given 40 per cent marks each and rest distributed as required by the employer. Assessment of the candidate may be made by written tests, practical tests and individual and group discussion. Many large organizations such as Railways, Defence, Post and Telegraphs and Public and Private Sector Companies prefer to recruit fresh Diploma holders through written tests and interviews. Selections are made in a highly competitive field and the best talents available are recruited. These persons are given two to three years training at the end of which they are placed in suitable positions.

Placement and Maintaining Close Contact with Industry

Polytechnic authorities should keep a record having the particulars about salary, present status etc. of their alumni. Also there should be a get-together of past and present students annually to create a brotherly feeling which may help to get information on job particulars for the use of students. The teacher in charge of training arrangements may be asked to visit the various establishments periodically to collect the job information for the students in such establishments.

In fact, assistance in getting jobs after training should form part of the work of the polytechnic and there should be continuing liaison between the polytechnic and industrial/engineering establishments in this respect. There should also be more exchange between industry and teachers who are involved in training of technicians. It is important that advisory bodies be formed for all industries so as to tincilitate the exchange or ideas between the polytechnic institutions and industries.

Emoluments of Technicians and Ensuring Vertican Mobility

Diploma holders may be started on a minimum wage of Rs. 250 per month but gradually as they gain more experience and become fit to shoulder more responsibilities, there will be many opportunities for promotion in pay and status. They should also be encouraged to improve their knowledge by preparing for section A and B Examinations of the Institution of Engineers and more opportunities should be given by the industry; to capable and deserving diploma holders to improve their status. Initially, there may be some sort of antagonism from engineering graduates if diploma holders are employed in large number in big establishments. To overcome this opposition, some of the jobs at higher levels may be reserved for diploma holders who are capable of taking up more responsibilities and who are successful in joining the Institution of Engineers (India) as Associate Members instead of directly recruiting engineering degree holders as probationers. Some thought should be given to this ticklish problem early, before it assumes difficult proportions.

Formation of Association of Technicians

Associations of Technicians may be organised in big cities with the help of professional organisations or institutions and in collaboration with industrial establishments and colleges. Technicians possessing requisite diplomas with practical training and experience should be requested to join such associations. These associations, if established, may conduct meetings and conferences and conduct some joint meetings with recognised professional societies which will be useful for all concerned.

Facilities for Diploma holders to undergo Degree Courses

Some good students who were unable to join universities for the degree course, are forced to join polytechnic due to circumstances. They would like to join degree courses after obtaining their diploma from the polytechnics but facilities for them to enter the university are few and they are unable to pursue their studies further. Some of the more ambitious students with first class diploma in civil engineering do attend degree courses in the evening, *i.e.*, after regular hours of work and a number of them have already obtained degrees from the Jadavpur University. It is advisable that such facilities should be expanded so that the diploma holders who desire to acquire more knowledge and secure the engineering degree may have the opportunities to do so.

Ample scope for further studies for diploma holders must be given by setting up evening colleges and by other means.

Recognition of Diploma for Studentship Examinations of the Institution of Engineers (India)

There are also a few women's polytechnics in our country conducting courses in architectural assistantship and electrical communications. It is learnt from some of the diploma holders that the diploma granted for architectural assistantship is not recognised by the Institution of Engineers (India) for exemption in the studentship examination. The architectural assistantship course should therefore be suitably revised so that the Institution of Engineers (India) could recognise this course for exemption in studentship examination and the diploma holders in architectural assistantship are enabled to pursue their studies.

Refresher Courses

For up-dating and improving knowledge and skill, refresher courses or evening courses should be started. The courses can be given by the specialists from the industry and teachers from Technical Institutions.

Specialisation

Specialisation would be meaningless unless a technician has acquired a sound basic knowlege and a thorough practical training as envisaged for a diploma holder. Any specialisation, such as production engineering, Industrial electronics etc. should be taken up only after a person has successfully completed a course in Engineering.

It is desirable that the areas of specialisation are properly identified in consultation with industries. Specialisation in cases of fertilizer technology oil refining and in fields of such specific nature, should be undertaken by way of post academic training to suit that particular industry's needs.

As far as Textile Machinery manufacturing industry is concerned, the fields of specialisation will be:

1. Operation and Maintenance of modern and sophisticated machine tools,
2. Design and development,
3. Design and manufacture of jigs, fixtures and other production devices,
4. Process planning and production control,
5. Inspection and quality control, and
6. Erection and servicing of textile machinery.

Diploma holders who have acquired a sound theoretical and practical knowledge during the course of study may not fit in positions required by industry. It is therefore necessary for industries to provide postacademic training to make them to suit their needs.

Broad based Education Versus Specification

It is possible to introduce specific areas of specialisation in the polytechnic curriculum. But one has to look into the consequences of these, under the prevailing administrative and political set up in our country. This type of specialisation has been a great success in Russia and Germany. In Russia a thorough assessment of the requirement of personnel for the various industries under a particular category of specialisation is made and a limited number selected for imparting such a training. On the other hand in USA, the stress is on broad based education, which will give the person the opportunity to join any specialised field. Having been equipped with the fundamental technical orientation, it should be possible for one to learn and specialise after joining the industry. Both these view points have their *pros* and *cons.* We have to look into this question from the assessment figures of technical personnel, as conducted by the Government of India, required under various categories, for the five year plans have more often proved to be completely different from the actual situation at various times. This is to be attributed to the unsound economic conditions, unpredictable labour situation and recession in industries. Under the present conditions of political set up it seems that a broad based education in the polytechnics would be preferable as this will be least harmful from the point of view of the future career prospects of graduating students. Highly specialised personnel if denied employment opportunities in the respective industries concerned will not be in a position to explore avenues of employment elsewhere.

Limited Specialisation

Demand for specialisation is on the increase. Only areas of specialisation, which will increase the useful contribution of the candidate to the organisation employing him but not unduly restrict his job opportunities should be introduced. Introduction of other specialisations must be based on statistics regarding the demand for qualified people in that line.

Fields of Specialisation

Specific areas of specialisation may be introduced like Production Engineering, Commercial practice, Safety Engineering, Maintenance Engineering, Industrial Electronics, Building construction, Process Metallurgy, Oil Refining, Fertiliser Technology, Textile Processing, Plastics, Standardization etc. This could be combined judiciously with definite durations of academic learning in polytechnics.

It would be a good idea to introduce short courses in highly specialised fields in the polytechnics to experienced personnel in the industries.

The needs for specialisation can be met by evening courses. These also can serve as refresher courses to existing technicians. However, these courses must be conducted by specialists, preferably from the industry.

Specialisation for Structural Steel Work

Fabricating Industry

Specialisation in any particular field of the Engineering Industry will help not only the industry but the Technician also even from the early stages of his appointment. The fields cover subjects like science of metal forming, hydraulic engineering, insrumentation and the like and the specialisation of the technician in that subject should cover both his technical know-how and the skill to perform the task given to him.

This accomplishment is possible when the student learns that subject in particular even from the beginning of his career in the Polytechnic and at the same time picks up the field by working in the shop floor of any industrial unit.

A period of four to five years is considered sufficient to achieve this objective. During this period the student works continuously in an industrial undertaking during the day to pick up the skill of his trade and attends night classes to learn the theory and application of the subject.

This system of education does away with the post academic training by the employer while at the same time he knows the applicant intimately as he has maintained his (applicant's) records for five years.

For those who do not seek specialisation, the polytechnics can continue to function as it is now doing, giving the student courses in all the three branches of Engineering, *i.e.*, the Civil/Structural, the Mechanical and the Electrical with 'Sandwich' training so that these technicians can find work or employment in the various projects undertaken by the Central and State Governments under the Five Year Plans. Those projects can as well engage the Technicians during the period of construction when they will be called upon to help in the erection and installation and for some time maintain the plant and machinery.

5.3.8. Institution-Industry Cooperation

The liaison between the industry and the polytechnics at present is poor. To keep the teaching geared to the needs of the industry, a close liaison must be established between the polytechnics and the industry. The industry must be involved at all stages in the following functions, *viz.*, deciding the courses to be offered, framing of the syllabus, arranging the persons from the industries to teach (part-time) and be examiners, project and research works etc.

The degree of participation of the industry in the diploma education at all stages beginning from the courses to be offered, syllabus, teaching, examinations, practical training, etc. should be spelled out clearly and the industry must be made to participate, through legislation if necessary. Since it is the industry that wants technicians with practical orientation, it is mainly its responsibility to see that the course is made as practical as possible by deputing its experienced staff for part-time teaching, by arranging for supervised sandwich training of students and polytechnic staff, and by examining the students at the end of the course. The industry will be put to some trouble if it releases some of its staff for polytechnic work, however, it must bear this responsibility in the interests of training.

Wherever possible representatives from nearby industries should visit the technical institutes to deliver lectures, lead group discussions, distribute handouts, flow diagrams etc. In other words 'know-your-industry' must be the motto. This kind of rapport will enable the students to be correctly oriented to industrial culture. The talks need not be only technical; they could and should cover other aspects of factory activity namely:—Personnel Administration, Rules and Regulations, Welfare Schemes, Promotional Opportunities, Industrial Relations etc. On a reciprocal basis opportunities must be provided for the teaching staff of the institutes to spend their time in industrial establishments to acquire first-hand knowledge of the process, machinery and other aspects of industrial management. This kind of orientation will improve the effectiveness and versatility of the teachers which in turn will improve the quality of their teaching.

Many of the progressive industrial organisations have started this kind of rapport with the technical and engineering institutes. Their representatives make it a point to go round the various institutes, meet the staff and students, disseminate company information, discuss problems of common interest and in the bargain select promising final years students for future employment.

There should be close liaison between technical institutes and the industries in drafting the curriculum and re-orienting methods of teaching and training. The curriculum should be revised once in every 4 or 5 years keeping in view the technological advances made and in accordance with the needs of the industries.

Spelling out Responsibilities and Creation of Machinery for ensuring discharge of Responsibilities.

The responsibility of the Government, the Polytechnics and the industry for the bringing up and maintaining the polytechnic education at a satisfactory level are not specifically defined. Unless the responsibility of the three parties involved for the curriculum, staffing, administration, finance etc. are clearly defined and a suitable machinery to see that these things are carried out properly, is set up, no significant improvement will result.

5.3.9. Special Needs of some Particular Industries

Training of Technicians in Cement Industry

Most of the A.C.C. Factories are situated in out of the way places which limit the scope for any worthwhile liaison with the technical institutes of the region. The geographical limitation has brought home the compelling necessity of self-reliance in so far as training of their technicians is concerned. Therefore, the A.C.C. have established full fledged centres for the training of their skilled workers and technicians in their own factories with the help of their own instructors. This training is essentially job oriented covering the important trades and activities commonly met with in cement industry. More recently they have organised comprehensive training schemes, extending from 6 to 12 months, for the freshly recruited engineering and non-engineering graduates who will eventually man the middle level of factory management. This training is partly conceptual and partly technical, the central theme being to impart basic knowledge and skills regarding cement technology and modern concepts and techniques of supervision and management.

Cement manufacture is a continuous and exacting process involving heavy machinery like crushers, grinding mills, rotary kilns etc. in a production network of 600 to 2200 tonnes per day. Likewise there are other heavy industries manufacturing basic commodities like steel, fertilizers, sugar, paper etc. each signifying a specialisation of its own. In the circumstances it would neither be advisable nor possible for the engineering or technical institutes to adopt a curriculum which is closely oriented towards such heavy industries. But what is essential is that these institutes should produce diploma holders who have basic knowledge of engineering disciplines and the skill to apply this knowledge in such engineering and process industries.

Post Academic Training Provided in the Structural Steel Work Fabricating Industry

The selected candidate undergoes a period of training which will last from one to two years at the works and from three to four years in the drawing office. He should first of all get acquainted with the materials handled in his departments and for this purpose he spends sometimes at the shop floor whether he is chosen to work there itself or at the drawing office.

After getting the 'feel' of the materials, their weights, dimensions and other physical properties and after actually seeing them handled, he will be able to appreciate what effort is involved in processing them. This experience is very vital to him for giving proper instructions to the worker. Actually he should be able to apprise the magnitude of the end-product in order that he may get the sense of proportions of the various members and components that go to make that product. It is this sense that will help him to become a good engineer. His training here is rounded off with his completing a course of specialisation in any or a combination of a few of the following items of work:

1. Structural shop : Welding, Assembly etc.
2. Machine shop and assembly.
3. Electrical Shop : Making Panels and Electric Wiring etc.
4. Inspection Wing: Tolerances, workmanship, quality control, finish etc.
5. Study of Jigs and Fixtures for saving production costs and getting quality product.
6. Work-Study, Time Study etc.
7. Maintenance of machinery and equipment and installations.
8. Study of Erection procedure in each branch of work under Items (1), (2) and (3).
9. Study of servicing problems.

However, before selecting him for appointment at the works it is assured among other things that (a) he has the aptitude for that kind of work, (b) he has the requisite bearing and physical fitness to command the respect from the labour force (c) he has acquired the requisite skill and know-how during his training period to give correct instructions to the workers and solve simple problems when they occur.

When the applicant is selected for working in the Office, he is given training in any one or a combination of some of the following areas of specialisation:

1. Designing and making detailed drawings.
2. Estimating—materials, cost etc.
3. Preparing cutting lists—allotting materials for various works.
4. Study of various specifications like the I.S.S. the B.S.S. the Russian, the Continental and the American Specifications, Study of various Acts like the Electricity Act, the Factories Act, the Explosives Act, the Mining Act etc. etc. the Rules or Procedure and Practice, conventions etc. etc.
5. Study and examination of the various items of purchase, their specifications, quality and other physical and chemical properties.
6. Study and examination of tender documents and preparing preliminary data for final submission of tenders etc.
7. Maintaining documents and dockets on the various works in progress.
8. Study of the various items manufactured by the Unit for the promotion of sales.

Training Programmes in Paper Industry

One paper manufacturing unit provides the following training programmes:

1. One programme for the freshly recruited qualified engineers.
2. Another for matriculates.

Training Programme for Qualified Engineers

The objectives of the training programme which is of 11 months duration are given below:

1. To familiarise the fresh graduates with the pulp and paper technology; and industry.
2. To develop the technical know-how relating to the particular fields of engineering and technology.
3. To give essential information about company's policy, organisation, administration and personnel.
4. To develop an appreciation of the expanding mental universe and to acquaint them with the wider world in which to live and work.
5. To instill a spirit of inquiry and search after truth leading to a right attitude towards and an aptitude for research and work.
6. To get acquainted with the methods and techniques of modern management and to develop in the Graduate Engineer Trainees (G. E. Ts.) the following qualities in particular:

Analytical ability and balanced judgement;

Capacity to solve problems and reach decisions in a sound and well organised manner;

Vigour of mine and of imagination;

Ability to work with—and lead—others;

Understanding of human behaviour and of social, political and economic forces;

Character that assures adherence to high principles under stress conditions;

Ability to keep an open mind and to continue learning on one's own initiative.

Training Programme for Matriculates

This programme includes lectures on pulp and paper making techniques and fundamentals of plant maintenance.

The full training programme is of 2 years' duration having two terms. The first term is of about 8 months and the second one is of 16 months duration.

The first term consists of refresher courses in physics, chemistry and mathematics, engineering drawing and English and in the second term, the principles of pulp and paper making are taught. The total number of periods is about 128.

For the convenience of the participants only three periods per week are conducted, each period of 1½ hours duration. The training programme is conducted by experienced officers of the company, both from process side and from the engineering departments. Tests are also conducted at certain intervals to assess the progress of trainees.

Technician Training Required for Thermal Power Stations whether Polytechnics can run these courses

During the fourth five year plan the power generating capacity in the country is proposed to be increased from ten to twenty two million kW of which seven million kW will be thermal power. The modern thermal power station which utilises large units operating on high steam parameters is a complex arrangement of equipment involving various specialised fields of mechanical, electrical, electronic, control and instrumentation engineering, and water chemistry. The risk involved in maloperation is very great as the equipment in the station is very complicated and costly. This calls for properly trained personnel for the operation and maintenance of thermal power stations. It is no longer possible to meet these demands for skilled personnel from existing reserves and it is necessary to resort to a comprehensive scheme to train up thermal station personnel particularly in view of the high degree of sophistication involved in the various fields of engineering associated with the designing of modern thermal stations.

In the context of rapid expansion of thermal power generation during the next five years it is estimated that about 14,400 operation and maintenance personnel in the following categories will be required for staffing the additional thermal power:

Skilled personnel	Nos.
Senior Engineers	280
Junior Engineers	1310
Subordinate Staff (Operators & maintenance technicians)	4230
Other Staff : Attendants	8550
TOTAL	14370

At present Training Institutes at Delhi, Durgapur and Neyveli, provide one year's special training for diploma holders to make them suitable for taking up responsibilities as technicians. They account for a total in-take of about 190 candidates. This is not enough to meet the requirements.

The courses provided at Durgapur are for:

(a) Electrical Operator,
(b) Electrical Maintenance Staff,
(c) Mechanical Operator, and
(d) Mechanical Maintenance Staff.

Candidates with diploma in electrical or mechanical engineering or with degree in science are admitted to these courses. Candidates should be sponsored by their employers. Preference is given to candidates with at least one year's experience in steam power plant operation.

The Central Water and Power Commission therefore states:

> "In this context, it is felt that the programmes of training being imparted to Technicians at the Training Institutes will be considerably benefited if the present course of education and training at the Polytechnic level in the concerned field of engineering are so oriented as to cover a good part of curriculum (both theory and practical training) laid down in the Training Institutes such as Durgapur run by the Central Water and Power Commission".

Meeting Technicians needs for the Vegetable Oil Industry—whether Polytechnics can train them.

The Vegetable Oil Industry estimates that it may require 50 trained persons every year. The Vanaspathi factories in the West and North zones may require such personnel. With reference to the nature of the jobs entrusted to them they range from higher level process operators to technicians. Currently these positions are filled by personnel who have started as workmen in the plant and become operators on the basis of job knowledge and experience gained in the plant itself. The promotion potential of this group is obviously limited especially when no rigid educational standards are prescribed at the stage of initial recruitment. Such was the case in most of the industries till very recently. Quite a few progressive employers have sought to overcome this difficulty by different forms of apprenticeship schemes of their own. The common feature of these schemes is the recruitment of young intelligent matriculates and training them for a period of three to five years to take up positions as plant operators who have potential to be promoted as technical supervisors. Polytechnics can usefully take up the responsibility of meeting this specific need.

Special practical oriented training in specific process industries can be made part of the polytechnic curricula perhaps in the final year. Training should include laboratory tests relating to the specific industry. In the case of vegetable oil industry, the curriculum should include tests of raw oils, process materials and finished products such as edible oils and vanaspathi, and plant operations such as neutralisation, bleaching, hardening and deodorisation. Since soap making often forms an integral part of the vegetable oil industry, general aspects of soap manufacture should also be included in the syllabus. The training of personnel who are eventually to be absorbed in an industry will not be complete till they acquire some practical experience in the concerned industry. Sandwich courses will play an important role in this respect. Students can spend one or two spells of eight to twelve weeks in an industrial establishment before they are awarded their final diplomas. The later during their courses they undergo this practical training, the better equipped will they be to derive the best out of it. Industrial establishments in which the young trainees will be placed should be given an opportunity to interview them before placement. This will ensure a commitment on the part of the establishment to provide proper facilities and supervision for the training of the students. The students will not be left to their own resources, which is often the case when students are placed for training in industrial establishments and such placements are accepted for no more than reasons of public relations.

Further, the suggested procedure will provide an opportunity for the establishments to fit the training of the student trainees in their plans for future recruitment and thus the prospects of employment of the trainees in the establishment in which they undergo training will be considerably enhanced. Promoting the employment potential of the students of any educational programme is an essential prerequisite of its eventual success.

Special Diploma Course in Agricultural Engineering

The need has been expressed for a separate diploma course in Agricultural Engineering in order to supply technicians who would be useful to undertake repairs and maintenance of tractors and other Agricultural Machinery, and in irrigation and soil conservation work. The University of Agricultural Science, Bangalore has started an institution at Raichur for conducting a diploma course in Agricultural Engineering.

It is estimated that about 400 Agricultural Engineering Technicians will be required annually during the Fourth Five Year Plan period. Another view expressed is that a separate diploma course in Agricultural Engineering is not necessary and that it is enough if students taking the Diploma course in Mechanical Engineering are made to specialise in Agricultural Engineering during the final year of the course.

Unsuitability of Diploma Holders for Employment as Technicians in the Aeronautics Industry

Diploma holders fill in an important gap between the workers and managers in industry generally. In HAL, this interface is termed the 'Asst. Supervisors level'. At the shop level, the Assistant Supervisor is required to directly advise the workers both in the technical and human relations area. The technical component of this work may not be intellectual but is highly specialised in the manual tasks. Unless a diploma holder is trained intensively for two to three years, he will not be able to achieve the required proficiency in this field. As for the human relations component, it will be difficult to train diploma holders to manage highly skilled groups of workers and administer them effectively. These are two reasons which militate against the employment of diploma holders as technicians. A third and a more critical reason is that the management does not have a free hand in employing fresh Diploma Holders to vacancies of Assistant Supervisors as and when they arise. This is so because the Unions are directly involved in such a decision and will be loath to deny their members of the only chance of promotion above workers' level which they now possess exclusively.

5.3.9. Future Needs

Manpower requirements of Technicians

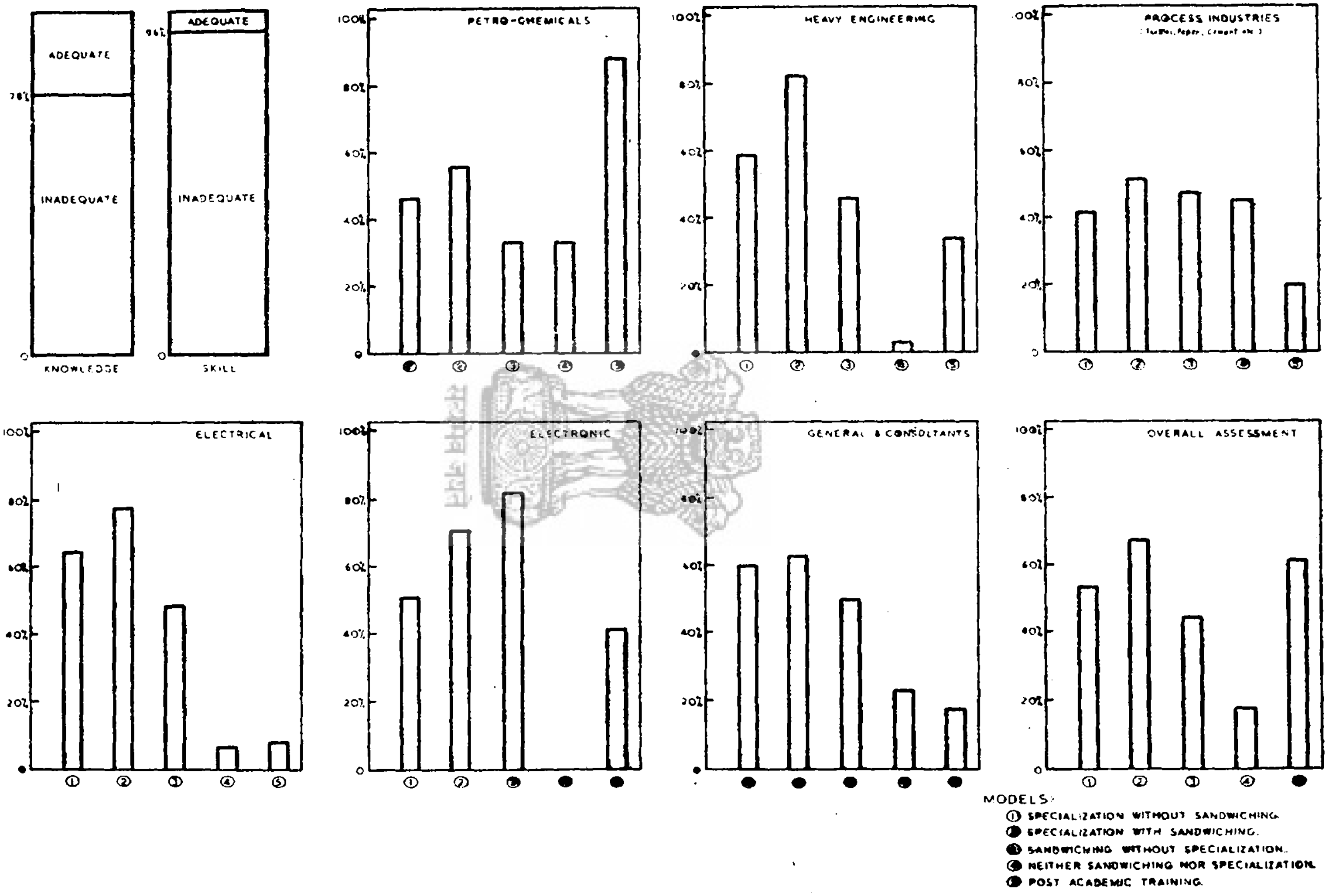
The following estimates have been received of technician requirements during the fourth plan period :

	For Five Years
Manmade fibre industry	4000
Vegetable Oil industry	250
Cement industry	No new units
Thermal Power Stations	4000*

*includes operators,. Separate figures for technicians are not available.

Estimates have not been received from other industries.

FIG 5.2.1 DEGREE OF SUPPORT FOR VARIOUS MODELS



6. LIMITATIONS OF THE SURVEY

For purposes of valid statistical interpretation of any data, it is necessary that the data is gathered from a fair size representative sample of the 'universe' on which the study is made. Where necessary, the 'universe' may also be stratified so that a fair representative sample is drawn from each stratum or layer comprising the universe.

In the present survey, certain 'experts' were selected for each field of industry and the number of units or companies to be studied was left entirely to their choice. The principle of objectivity cannot therefore be totally presumed in this case. For this reason it would not be correct to claim substantial validity to the statistical data gathered during the survey which was more in the nature of a qualitative assessment of the present situation. Subject to this limitation, an attempt has been made to analyse the data on employment of technical personnel, in the hope that the results may give some idea of the situation.

7. NEED FOR A CONTINUOUS INDUSTRIAL SURVEY

With the rapid advances in Science and Technology, there are vast changes in the methods of Industrial production. This in turn calls for the Industrial Activity in all its spheres to be adjusted periodically to suit the immediate needs, shedding off of obsolete methods and processes and switching over to the current methods with minimum delay. To make this continuous adjustment, which has become a must now-a-days, more effectively, a scientific job analysis of the various works at present handled by the technicians in the industry, should be done continuously.

For each industry, job descriptions should be laid out for the various works done by Technicians such as design and development, erection and commissioning of equipment and structures, drawing and estimating, operating, maintaining and repairing machinery, process control, production supervision, inspection of raw materials, process material and finished products, work study, assembly, testing, sales organising and customer services. This should be continuously done. It is understood that the All India Manufacturers Association is having proposals to initiate such a Project Survey in the manufacturing industries with the collaboration of the Ford Foundation. This Project Survey which is proposed to be undertaken with the technical cooperation of NITIE should be thorough and continuous, covering all industries and all jobs normally handled by the technicians. The findings of such a survey should be made available to Polytechnic-curriculum-making-bodies, for making the necessary additions, deletions or changes in the course content of the various subjects taught.

Work of this nature should not be treated as one-time casual affair but should be part of a continuous organised work, which should preferably be entrusted to a responsible Standing Committee.

8. ACKNOWLEDGEMENT

The Chairman of CROPE wishes to express his sincere thanks to the following :

1. The experts and entrepreneurs and eminent persons who took the pains of contacting several industries and sent to the Chairman consolidated views of the industries in the form of memoranda, filled up questionnaires etc.

2. The professional associations, Chambers of Commerce, Institution of Engineers and other bodies like AIMA, IMTMA, SIEMA, the Cooperative Research Organisations like SITRA and SASMIRA, Structural Engineering Research Institute and the Central Water and Power Commission who have sent to the Chairman valuable suggestions and recommendations.

3. The top management personnel of the various industrial units throughout the country who have extended their fullest cooperation and given their valuable views.

Since it is impossible to individually thank all those who were instrumental for the success of this survey, the Chairman heartily acknowledges their contributions and thanks them sincerely.

APPENDIX—V(B)

REPORT OF JOB ANALYSIS SURVEY OF INDUSTRIES DONE BY TECHNICAL TEACHERS' TRAINING INSTITUTE, CALCUTTA.

A sample job analysis survey of industries was carried out at:

(1) Chief Mechanical Engineer's Workshop, Calcutta Port Commissioners.

(2) Indian Cable Co. Works, Tatanagar.

The analysis was carried out with a view to obtaining information pertaining to re-organization and development of curriculum for education and training of technicians. The details of information obtained are given at Tables I, IIA, IIB, IIC, and IID.

From this information certain important conclusions emerge regarding education and training of technicians, not withstanding the fact that the survey conducted was of the nature of a pilot study. The summary findings of the survey are as follows:

(1) The conventional fields of engineering *viz.*, Civil, Mechanical, Electrical etc. for educational purposes need to be diversified into different technician specialities, *e.g.* Mechanical—Production, Mechanical-Maintenance, Electrical-Production, Electrical-Maintenance, Civil-Construction and maintenance, etc.

The requirements of such diversification of technician specialities will, however, have to be determined by similar type of job analysis surveys conducted in a large group of industrial establishments.

(2) The prominent job titles/positions on which technician work are: Foreman, Supervisor, Chargehand, Planning Chaser, Design Draftsman, Technical Assistant, Quality Control Inspector, Estimator, Lift Inspector, Meter Tester, Diesel Supervisor, Shipwright etc.

(3) The educational qualifications of technicians in position are under:

(a) Matriculate with apprenticeship training or on the job experience . . . .
(b) B. Sc with apprenticeship training or on the job experience
(c) Diploma in Engineering } 50—65%
(d) Degree in Engineering } Negligible % age

(4) The ratio of Engineer Technician varies from 1 : 6 to 1 : 8 and that of Technician : Craftsman 1 : 7 to 1 : 20.

(5) The duties/tasks performed by the technician are as under:

(a) Most of the technicians perform supervisory jobs of getting production through craftsmen.

(b) The technician does not perform the skilled job during his normal day to day activities, but he is required to demonstrate the performance of skilled job to the craftsman under him as and when, necessary.

(c) A technician must have ability to plan, organise and control the activities of the section under him.

(d) The technician should have ability to communicate effectively with the engineer on one hand and craftsman on the other.

(6)(i) For the performance of his duties/tasks, technician must have theoretical knowledge of materials, equipment, and tools used. This should find a place in his curriculum of studies and training.

(ii) A technician must possess a detailed knowledge of the various parts of tools and equipment and their operations. This requires that in his curriculum for education and training he must be given practice in dismantling and assembling of equipment.

(iii) The technician should have practical skill in engineering measurements. This requires a provision for a course on metrology.

(iv) Most of the technicians do not work on a drawing board, but must be able to read Blue Print/ Technical drawings and make good sketches of machine parts and lay out of processes. This requires emphasis on the course work on reading of Blue Prints and sketching.

(v) A technician must have a sound knowledge of maintenance of equipment. This involves the knowledge of trouble shooting, wear and tear of machine, erection, operation and machine repairs. This could best be imparted during the in-plant training organised at the industries while the theoretical principles behind maintenance should be taught during the institution training. The theoretical training must include the principles of preventive maintenance.

(vi) A technician should possess a sound knowledge and practice of supervisory techniques. This involves study of such subjects as:

(a) Human relations, (b) Communication, (c) Accountancy/Cost economics (d) Work study, etc.

(7) Overall review of the duties/tasks, knowledge, skills and responsibilities technicians indicates that whereas certain knowledge and skills could be imparted during institutional training. Certain specific knowledge and skills which vary from industry, could only be suitably imparted during in-plant/industrial/appreticeship training. It is necessary that technician education must have the component of industrial training along with institutional training for complete development of technician to suit varied requirements of industrial jobs.

APPENDIX 5-B

TECHNICAL TEACHERS' TRAINING INSTITUTE, CALCUTTA

Job Analysis
TABLE I
(Survey conducted by
S.S. Panjwani)

Name of Industry INDIAN CABLE CO. LTD, TATANAGAR:

An analysis of
1. the main subject/areas of engineering in which technicians work.
2. the manner of grouping of the technician specialities for their educational development.
3. the job-titles/positions of technicians in different engineering enterprises.
4. the number of technicians required in any branch of engineering activity as ratio of Technician : Engineer and Craftsmen: Technician.

Filed of Engg	Activity	Function/Technician areas of work	Technician Titles/positions	Numbers E	T	C	T:E	Ratio C:E	C:T
I. MECHANICAL	1. PRODUCTION	(i) Production planning	FOREMAN	15	109	1041	7·3		9·6
		(ii) Rod rolling	CHASER-Planning						
		(iii) Wire drawing & stranding,							
		(iv) Wire enamelling and winding,							
		(v) PVC or paper insulation Power Cables							
		(vi) PVC or rubber insulation General Cables	MATERIAL HANDLING						
		(vii) Cable drums & Cases							
		(viii) Raw material Stores & movement.							
	2. MAINTENANCE	(i) Design & Drawing,	DESIGN DRAUGHTSMAN						
		(ii) Mechanical Plant Equipment & Tools maintenance including Forge & Smithy	FOREMAN, CHARGEHAND						
		(iii) Project development	STORE-KEEPER	5	33	127	6·6		3·9
		(iv) Engineering Stores							
II. ELECTRICAL	1. PRODUCTION	(i) Product standardisation,	TECHNICAL ASSISTANT, TESTER,	3	21	32	7		1.5
		(ii) Testing & Quality Control,	Q.C. INSPECTOR, CHECKER						
		(iii) Works Accounts/cost estimation.	ESTIMATOR						
	2. MAINTENANCE	(i) Electrical Plant Equipment & Tools maintenance including Gas & Water Plant	FOREMAN, CHARGEHAND INSTRUMENT MECHANIC	1	13	44	13		3.8
III. CIVIL	MAINTENANCE	Civil construction & Maintenance of works including Machinery foundations.	FOREMAN	1	2	20	2		10
IV. METALLURGY	PRODUCTION	Process development	METALLURGIST	2	1	0	0.5		0
V. TECHNICAL CHEMISTRY	PRODUCTION	(i) Product development,	CHEMIST	2	12	7	6		0·6
		(ii) Laboratory testing of raw & finished materials							
		TOTAL (Entire Factory)		29	191	1271	6·6		6·7

TECHNICAL TEACHERS' TRAINING INSTITUTE, CALCUTTA

Job Analysis

TABLE II A

An Analysis of 1. the cluster of skills and responsibilities of technicians in different engineering activities
2. the knowledge, skills and attitudes/responsibilities required of technicians for development of teaching/training curriculum.

(Survey conducted by S.S. Panjwani)

Name of Industry—INDIAN CABLE CO. LTD, TATANAGAR

Field of Engg. Mechanical

Techcician Titles—Foreman, Chaser, Planning, Chargehand, Materials Handling Officer.

Activity—Production:

Functions—Production planning, Rod rolling, wire drawing & strading, wire enameling and winding, PVC or paper insulotion Power cables manufacture PVC or rubber insulation General Cables manufacture, cable drums and cases, Raw materials stores, & movement:

Job content/Tasks (Cluster of skills and responsibilities)

1. To calculate machine loading
2. Post the machine with order
3. Calculate the surplus machine capacity
4. Co-ordinate with different departments to make use of available capacities.
5. Chalk out the monthly production plan break, the monthly plan to daily schedule
6. Check raw materials position and uniform stores
7. Chase & maintain production schedules
8. Getting production—Plan co-ordinate and control production activities
9. Allocation of work to men & machines
10 Maintaining worker discipline.
11 Materials quality control
12. Motivating workers-explaining Company Policy
13. Grant of leave to workers
14. Laying down promotional policies for workers
15. Training of workers
17. Minimise scrap and waste
18 Product development
19 Maintaining production records reports
20. Requisitioning of materials & Tools
21. To supervise production and check various operations involved in manufacture of covered conductors as per specifications
22. To supervise operation and maintenance of drying oven
23. Operation of Fire extinguishing equipment
24. To supervise production and operation of stranding machines paper cutting machines, laying up machines, impregnating Plant, Striping machine, armouring m/c & lead press
25. Check the quality of production *e.g.*, size, shape, length lay depth/dia. insulation etc., during and after processing.

Materials, Equipment & Tools used knowledge, skills and responsibilities

Materials, Equipment and Tools used. Copper and Aluminium conductors, strip and wires : Steel and C. I. Strips ; Paper, cotton, cloth, Hessian insulations, enamelling compounds, impregenating compounds, rubber, lead, PVC compounding materials, different types of woods/timbers, Calculating machines- Hand ; Electric and Electronic operated ; Slide-Rule Rod Mill, Weighing Machines, Winding machines, wire dies, Drying oven, stranding machine, paper cutting machine, laying up m/c, impregnating Plant, striping m/c, armouring m/c. Lead Press, Wood working machines Drilling Routing, Grooving, Planning Band Saws, Auto-vehicles, Micrometer Pyrometer, Thermocouple, Wire Gauges, Weighing Scales, Diamter type. Pressure Gauges, Vaccum Gauges Temperature recorder, Carpenter's Tools.

Knowledge & Skills Shop calculations, Cable specifications, Machine specifications and capacities, process operations, Machine loading, Production schedule, operational working of Rod Mill, wear and tear of machine parts, working of Rod Mill, wear and tear of specifications of finished products, Mechanical hand tools, Labour control, Production control, selection of dies, defects in dies, Quality control of products, stores indenting proved uses, preparation of production records, dates and charts, lubrication of machines, machine speeds, converstion, tables, specification and construction of paper and cotton insulated conductors, care of tools and raw materials, Measurements, Maintenance of Gauges, equipment etc., sizes and grades of wires, weights—conversion tables, Drying oven-operation and maintenance, testing of wires, waste control, House-keeping Leadership Discipline, Motivaton of workers, calculation of diameters, production quantities, construction/ operational details of various production m/cs. setting of machines for different operations, manufacturing process cycle/sequence of operations, supervision of operators, preparation of accident reports, different types of cables—counts ends of cotton and jute, size of the conductor or core, types of different cables and strand processes, lay charts of all machines, finish of cables, Bunch and Strand of cables, various types of sizes of tapes, various grades of insulation, lay tension of rubber, over conductors, quality and plasticity of rubber, extruding techniques, cure time for vulcanizing, curing cycle, Different types of wood-care, inspection, storage and cost. Cable drum manufacturing operations and process. Carpenter's tools, types, care and maintenance Wood working machies working/operation principle.

Job content/Tasks (Cluster of skills and responsibilities)		Materials, Equipment and Tools used knowledge, skil and responsibilities
		wood working operations, planning for manufacture; Operation and maintenance of Auto-vehicles, sound knowledge of trouble shooting, repair and maintenance of Auto-vehicles, Materials handling equipment for loading and unloading.
26. To check lubrication of machines	Knowledge & Skills	Skill, in : Use of calculating machines and slide-rule, Rod Mill operations, Change of rolls, setting Grooves, checking section of rods at different stages of manufacture, wire mill operation—selection of dies, guide workers on machine operations ; To check gauges of wires and isulation materials. To conduct tests on wires, to operate and maintain drying oven, To read Micrometer, to weigh, to set gear mechanism set strands, rectify, defects, to read vaccum gauge, temperature Recorder, Ability to perform/demonstrate cable manufactureing operations on various production machines, to check dimensions of care and insulated conductors, Measurements on wood work, Trouble shooting of Autto-vehicles.
27. To check safety guard of machines		
29. To check dies of machines		
29. To check vacuum pumps		
30 To check steam supply		
31. To supervise coiling machines, production of thermoplastic covered cables, braiding, stranding machines, lapping machines, taps cutting machines taping machines, core printing machines, cable Extruders, rubber slitting machines, rubber and paper printing machines.		
32. To arrange testing of cables.		
33 To arrange repair of equipment under breakdown		
34. To label and despatch materials produced.		
35. To arrange to check rubber for quality and plasticity		
36. To check machine running condition, wear and tear.		
37. To arrange tools, stores and distribute among workers		
38. To read drum shop costing memo sent by Estimator		
39. To supervise the carpenters and manufacturing operations for production of cable drums and cases		
40 Maintenance of sectional records and reports etc.		
41. Allocation of vehicles to various departments.		
42. Programming and distribution of wires and Semi-processed cables.		
43. To ensure correct weighment of materials	Work conditions & Responsibilities	Work in office, shop floor, in shits, warm temperature near the furnace, abnormal noise of the Mill, loading yard and Railway siding. Provided with table & chair. There are hazards of fire, burns from steam & hot compounds, falling of materials Gets general supervision from Engineer and directly supervises the work of Craftsman under him.
44. Arrangement movement of raw materials, Semi-processed products drums etc.		
45. To report on the running condition of the vehicles and its utilisation.		

TECHNICAL TEACHERS' TRAINING INSTITUTE, CALCUTTA

TABLE II B Job Analysis

Name of Industry INDIAN CABLE Co. LTD., TATANAGAR.
Field of Engg : Mechanical : Activity : Maintenance.

Technician Titles : Design Draughtsman, Foreman, Chargehead, Storekeeper

(Survey conducted by S.S. PANJWANI

Functions—Design & Drawing Mech. Plant Equipment and Tool maintenance including Fore & Smithy*,

An Analysis of:
1. the cluster of skills and responsibilities of technicians in different engineering activities.
2. the knowledge , skills and attitude/responsibilities required of technicians for development teaching/training curriculum.

*Project development Engineering Stores

Job Content Tasks (Cluster of skills and responsibilities)

Materials, Equipment and Tools used : Knowledge skills and Responsibilities.

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1. Calculations in designing m/c parts.
2. Sketching of machine parts.
3. Drawing of machine parts.
4. Checking of drawings.
5. Preparation of weekly duty list for allocation of workers to different sections.
6. Allotment of work to different workers.
7. Estimation of time of repairs.
8. Supervise and guide the skilled workers in repairing, overhauling, general and preventive maintenance of Plant and Production m/cs.
9. Arrange tools, Spare parts and raw materials.
10. Maintain discipline among workers.
11. Prevention of accidents.
12. Preparation of daily report of repair/work done.
13. Planning and Preparation for scheduled and preventive maintenance.
14. Guides and supervises the skilled workers on jobs involving machining of spares, turning, grinding, shaping drilling etc.
15. Allotment of work on various machine in machine shop.
16. Checks the machine operation in the shop.
17. Guides the craftsmen in shop calculation.
18. Maintenance of steamlines, water lines, gas lines and compressed air lines.
19. Fabrication of guards, covers, stands etc.
20. Maintenance of light furnaces.
21. Supervision of Black Smithy, Moulding welding and Heat Treatment jobs.
22. Supervision of Gas Generator.

Materials Equipment & Tools used

Pencil, drawing paper sketch pad, Eraser, drawing ink, cotton jute, oils, grease, clearing compounds, Drafting m/c. Drawing m/c. Drawing Instruments, Gear, paper slitters, Mould boxes, Dies, Cores, Hubs & sprockets, Winding drums, Air compressors vulcaniser, Breading m/c extension press scroll, speed variator, Traverse screw, Tinning bath, Flaker, stranding & Punching m/c] Twining m/c Tapping Head, Capstan and drive mechanism Electric Hoist, Hopper, Ducting Air filtration plant, Wire drawing m/cs, stranding & armouring m/cs, enameling m/c, Extruders, Power presses, Rolling Mill, oil fired furnaces, steam Boilers, centrifugal pumps, Gear Pumps, Rubber mixing and calendering m/cs, laying up and insulation m/c winding m/c reeling m/c overhead cranes, hoists and chain blocks, Machine Tools-milling, Turning, Grinding, Shaping and drilling, Power hammers, shearing and Punching m/c Wood working m/c Cores and dies for cable extension, laps for fire drawing dies, Rod mile guides, Power driven Hacksaw, Weighing machines, Set Squares, Foot-nile, Protector, slide Rule, Calipers, Micrometers, Verniers, Angle Protector levels, Gauges, Hand Tools, Thread Gauges,

Job Content/Tasks (Cluster of skills and responsibilities)	Materials, Equipment & Tools used : Knowledge, skills and responsibilities
23. Supervision of manufacture of Bolts & Washers 24. Maintenance of overhead cranes 25. Direct Supervision of lubrication of entire plant, and equipment. 26. Maintenance of weighing machines and measuring instruments. 27. Periodical checking of weighing m/c and measuring instruments. 28. Checking of important stores and spares. 29. Testing of Pressure vessels, Hoists, Chain Blocks, over head cranes etc. 30. Study of m/c. installation drawings. 31. Planning for installation of new machines. 32. Checking of m/c parts/according to specifications. 33. Preparation for foundation of machines. 34. Alignment and levelling of machines. 35. Fabrication of m/c parts for installation work. 36. Control of skilled and unskilled workers 37. Indenting of materials from stores. 38. Trial running of m/c after installatin. 39. Selection and preparation of specifications of stores materials. 40. Inspection of stores for correct quality and specifications. 40. Inspection of stores for correct quality specifications. 41. Stocking and issue of precision tools, Ball bearings and painting code numbers. 42. Stocking of materials in proper lines, tagging and painting code numbers. 43. Standardisation codification of stores materials. 44. Assist in auditing of stores.*	Knowledge and skills Feeler gauges, Electric Megger, Thermometer, Measuring taps, Principles of design of machine elements, stresses in materials and machine parts, Thermodynamics, Elementary mathematics, Trigonometry, Geometry, Solid Geometry, Algebra, Calculus, Co-ordinate Geometry, Strength of materials, Applied Mechanics, Metallurgy, Properties of materials, Fluid Mechanics, Meteorology, Indian Standard and British Standard Specifications, Preventive and Schedule Maintenance Factory Regulations, Labour laws, Fittig and assembling of macine parts, Lubrication of machines, Principles and systems of lubrication, lubricants, Grease, oils, Lubicating equipment, Machinery operations, Hand Power tools, Measuring Instruments, Blue Print reading, sketching, Jigs and fictures, Tools & Instruments, Workshop Calculations, Estimations and operations plannin Pipe lines & fittings, Plumbering, Welding, Forging, Blacksmithy equipment, Tools & operations, Heat treatment, Shearing and Punching m/c operations, alignment of crane rails Testing of pressure vessels and lines, Safety regulations Weights and measures Act, Leadership House, keeping, Principles of Supervision. Communications and Co-ordination, testing of hoists, Materials inspection, working Principles of different production, m/c sequence of fitting diff. m/c parts, checking of machine parts to specifications, alignment and levelling, Founcation of machines, Fabrication of m/c parts, Materials handling equipment, Safety equipment, Precision tools. Sketching of machine parts, tasking dimensions from m/c parts, laying of drawing, drawing, Fitting and assembling of m/c parts.

Job Contents/Tasks (Cluster of skills and responsibilities)	Materials, Equipment and Tools used : Knowledge, skills & responsibilities.
45. Preparation of stores indents for procurement.	
46. Maintenance of stores records daily receipt books G. R. R.. indents purchase orders	
47. Requirement of stores whose stocks fall below minimum level.	
Work conditions & responsibilities	Work in drawing office, Shop floor and Office, are provided with table and chair, work in shifts ; work in noisry atmosphere on the shops ; receive general supervision from Engineer ; responsible for direct supervision of skilled and unskilled workers by close guidance demonstration of jobs done by workers, Responsible for getting work done from workers motivating workers, responsible for reporting to Engineer the work done in the Section.

CHNICAL TEACHERS' TRAINING INSTITUTE, CALCUTTA

Job Analysis
TABLE II(C)

An analysis of : 1. the cluster of skills and responsibilities of technicians in different engineering activities.
2. the knowledge skills and attitudes/responsibilities required of technicians for development of teaching/training curriculum.

(Survey conducted by : S. S. Panjwani)

Name of Industry : INDIAN CABLE Co. LTD., TATANAGAR.
Field of Engg.—Electrical : Activity—Production : Functions—Product standardisation, Testing and Quality Control, Cost Estimation.
Technician's Titles—Technical Assistant, Tester, Q.C. Inspector,
Q. C. Chekcer, Estimator.

Job Content/Tasks (Cluster of skills and responsibilities).		Materials, Equipment & Tools used : Knowledge, skills and responsibilities.
1. Standardisation of cable products and cable design. 2. Preparation of manufacturing instructions for cable of special designs. 3. Technical correspondence with customers on cable performance,	Materials, Equipment and Tools used.	Paper Pencil, Graph paper, slide rule, knife, H. V Control Panels, Insulation Testers and Meggars resistance Measurement Bridges. Measuring Instruments..Ammeters, Voltmeters, Pyrometers, H. V. Schering Bridge. Physical Balance, Micrometer, Measuring tape, diameter measurement tapes, Hacksaw, foot rule, scales, calipers.
4. To conduct electrical tests on cables. 5. To check the test results with specifications. 6. Fault location and detection of cables. 7. To issue necessary test certificates. 8. To handle external inspection agencies. 9. Perform electrical tests for development work. 10. To follow the production process and compare with process instructions/operation for quality control. 11. Record the data regarding the quality of products.	Knowledge and Skills required.	Specifications of wires and cables, Properties of raw materials used in cable industry. Test standards for cables, Principles of Electricity, construction and functioning of electrical instruments and equipment, Mathematical Tables, Trigonometric Tables, Fundamental of Electronics, Cable production processes, process specifications, Basic science of materials, Graphical representation of data, distribution curves and deviation, knowledge of materials like Copper, Aluminium, Cadmium, tin, Plastic, rubber etc:, I. S. S. and B. S. S. Standards, Test calculations, Cost economics accounting procedure, Calibration of test equipment, accounting procedure, Calibration of test equipment, laying out of equipment for tests, Reading of equipment and instruments listed above, Micrometer measurements, use of electrical measuring instruments.
12. Advise production staff on any deviations found and advise rectification. 13. Process the data collected to prepare Quality Control Charts and graphs. 14. Determine the material utilisation and advise dates for cost estimation. 15. To establish the formulae for arriving at the net consumption of a material in a particular cable. 16. To calculate the projected cost of a product based on available datas and to forecast the profitability of the project. 17. Investigation of cost accuracy of standard products on data reported by shopfloor and other divisions. 18. Revision of direct labour cost under each	Knowledge & Skills required.	Specifications of wires and cables, Properties of raw materials used in cable industry, Test standards for cables, Principles of Electricity, construction and functioning of electrical instruments and equipment. Mathematical Tables, Trigonometric Tables, Fundamental of Electronics, Cable production processess, process specifications, Basic science of materials, Graphical representation of data, distribution curves and deviation, knowledge of materials, like Copper, Aluminium, Cadmium, tin, plastic, rubber etc., I. S. S. and B. S S. Standards, Test calculations, Cost economics, accounting procedures, Calibration of test equipment, laying out of equipment for tests, Reading of equipment and instruments listed above, Micrometer measurements, used for electrical measuring instruments.

Job content/Tasks (cluster of skills and responsisibilities)		Materials, Equipment and Tools used : Knowledge skills and responsibilities.
operation of finished products due to fluctuations of P.I. and charge in manpower on machines	Works conditions & responsibilities	Work in office, Test House and Shop floor, Possibilities of Electric shop and fire hazards, Gets general supervision from Engineer, and has to directly supervise skilled workers and clerks by close supervisions and actual demonstration/performance of jobs as required.
19. To guide in processing cost sheets (*i.e.,* calculation of materials contents in finished products calculation of despatch drum sizes, calculations of direct labour costs.		

TECHNICAL TEACHERS' TRAINING INSTITUTE, CALCUTTA

Job Analysis
TABLE II(L ,
Survey conduct ed by S.S. Panjwani

An analysis of : 1. the cluster of skills and responsibilities of technicians in different engineering activities.

2. the knowledge skills and attitudes/responsibilities required of technicians for development of teachching/training curriculum.

Name of the Industry : INDIAN CABLE Co. LTD., TATANAGAR

Field of Engg.—Electrical Activity : Maintenance:
Technician Titles : Foreman, Chargehand, Instrument Mechanic

Function-maintenance of Electrical Plant Equipment and Tools, operation and Maintenance of Gas and Water Plant.

Job contant!Tasks (Cluster of skills and responbilities).		Materials, Equipment and Tools used : Knowledge skills and responsibilities
1. Supervision of the following works : (i) Overhauling of Electrical Motors. (ii) Running maintenance of Rod Mill and Paper—Cables Factory, Equipment. (iii) Rewinding of Motors. (iv) Running maintenance of Wire Mill and General Cables Division Equipment. (v) Overhauling of control Panel Boards and Switchgears. (vi) Town/Colony electricity maintenance. (vii) Installation of lights and Fans. (viii) Medium Voltage Installations. (ix) Running maintenance of all electrical equipment including Control Panels.	Materials Equipment and Tools	Different components of Electrical machine, O. C. B. contacts, Power oil, Enamelled wire, insulations of different types, Binding wires, varnishes, lubricants, spare parts of control system, Cables, Overhead Copper Conductor, Insulators, Electric Poles Switches, Capacitors. Tube lights fittings, Regulators of fans, G. I. Pipes, Starters, overhead units, contacts Slip-ring, Carbon Brushes, Spare parts of electrical Instruments, Electronic valves, Transistors, rectifires Capacitors. Megger, AVO Tongs-Tester, Drilling m!c, Oil testing equipment, oil-making, Varnish heat chamber wih temperature control test lamp, Blow lamp for cable jointing, Ladders for overhead repairs, Motor, Control Panels, Electric welding m/c, Heaters, Power Capacitors, H. T. O. C. B. D. C., N. V. Potentiometer, V. T. V. M., Standard instruments for comparing, Multimeter. General Fitters Tools, General tools for winding, rotor balance testing, socketing etc.
(x) Preventive maintenance of electrical equipment including Control Panels. (xi) Maintenance and repairs of Ammeters, Voltmeters, Pressure Gauges, Automatic Temperature Controller, Electrical comiters etc. (xii) Maintenance of Telephones, Telephone exchange etc. 2. Supervision of Electricians. 3. General supervisory jobs pertaining to administration, discipline, safety, reports and records.	Knowledge and Skill	Performance of Induction Motors, Commutator Motors, Induction Regulators, Transformers and other electrical machines ; Duty- cycle and Heating of Motors, Maintenance of O. C. B. and transformers Principles of winding, different types and classes of insulation. Knowledge of Electrical machines and control systems, overhead, lines, L.T. distribution system, Cable jointing, knowledge of air-conditioning systems, Safety regulations, applicable to electrical appliances, Economics of installations, Working, knowledge of Motors, Control Panels, H. T. O. C. B., Fundamentals, of working of electrical Instruments, Basic industrial electronics, Working of telephones and telephone exchanges. To dismantle delicate electrical components ; to check conditions of winding, bearing etc. : Setting of O.C.B. Contracts : to check loading of motors—heating, noise, etc. ; loading of motors and transformers, End Connections, trial runs of assembled and erected machines ; checking and detecting faults in automatic control panels including electronic equipment ; expansion of electrical lines ; balancing of loads on the three phases ; wiring of buildings, tube light fittings, repairs of tube, checking of chokes and regulators ; to know circuit diagrams—check and detect faults thereby ; to check defective motors and arrange replacements etc· : checking of faulty stage in the electronic instruments, general inspection of instrument working to detect faulty line in the net work and relays in the telephone exchange.

Job content/Tasks (Cluster of skills of and responsibilities).	Materials, Equipment and Tools used : Knowledge skills, & Responsibilities
Works conditions and Responsibilities	Works in the Electric Repair shop, Instrument repair shop in the factory prodution shops, on doors in the township, with risk of mechanical injuries while assembling-damage to delicate parts in assembling, heat of rolling Mill, High Voltage hazards, O/H line hazards, 440V and 6·6KV,A.C. hazards, He gets general supervision from Engineer but provides close supervision including demonstration of actual job to electricians, fitters, winders and Coolies under him.

DIPLOMA EDUCATION IN INDIA

Questionnaire

I. Present syllabus and Curriculum:

1.1. Do you consider the present syllabus and curriculum of Diploma Education suitable for present day requirement of the industry?

1.2. If not, what specific changes would you like to recommend?

1.3. Do you feel that the present curriculum can be modified to suit the present requirement or should it be completely recast?

1.4. In case it has to be recast do you wish it to be broad based or do you feel that it would be better to have diversified and specialised courses?

1.5. If you favour diversification and specialization, would you suggest specialization superimposed on a scientific broad base or would you recommend separate and diversified courses from the very beginning?

1.6. Should the specialised courses be science oriented or technology oriented? What would be the quantum of mathematics and basic science content in various courses?

1.7. Keeping in view the changing needs of the industry what are the new courses which in your opinion could be introduced with advantage?

1.8. Should small and independent project work based on design, construction testing be introduced in the curriculum at the final stage of institutional training?

II. Workshop, Laboratory and Drawing Courses:

2.1. What percentage of total institutional training time is being devoted at present to (a) Workshop training (b) Laboratory Courses and (c) Drawing.

2.2. Do you think that the present allotment of time is satisfactory and serves to give the students insight into the subject and develops confidence?

2.3. If not what changes do you suggest in respect of (a) Time allotted (b) Curriculum. (c) Training method.

2.4. Do you feel that the training imparted to the students in institute workshops should be extensive and repititive in order to give a student certain amount of confidence in his own capacity to carry out work?

2.5. Or do you feel that they should have only basic workshop practice based on use of tools, gauges, operation of simple and conventional machine tools such as lathes, drills, shaping machine, metting machines different cutting tools, useful processes such as soldering, brazing, welding, steel metal work etc. in the institute leaving task of final training in the line of specialization to the industries concerned?

2.6. Or do you think that workshop training should better be left with the industry?

2.7. Should the workshop training in the institute be uniform for all types of courses or should it be diversified to suit the needs of different fields of training?

2.8. If you agree with the diversified training to suit different fields what type or types of workshop training would you suggest for the following industries?

(1) Heavy mechanical Engineering.

(2) Heavy Electrical Industries.

(3) Light Electrical, Electronic industries.

(4) Refrigeration.

(5) Structural Engineering.

(6) Irrigation.

(7) Instruments.

(8) Agro-industries.

(9) Automobile.

(10) Textile.

(11) Chemical.

2.9. Do you consider present workshop equipment in Diploma institutions adequate for imparting basic training or training programme suggested by you?

If not what type of equipment would you suggest?

2.10. Do you feel that laboratory courses as at present followed in diploma institutions serve any useful purpose in imparting either theoretical knowledge or practical training?

2.11. Should the laboratory courses in a polytechnic be built round (a) measurements of basic parameters, (b) setting up of apparatus, (c) Dismantling and erection of machines, (d) testing of machines and apparatus for their performance and (e) trouble shooting?

2.12. If you agree, what will be your suggestions for reorganising the Laboratory Set up?

2.13. If you favour specialization as suggested in Q. 1.5. would you favour Laboratory Course to centre round specialized course only or should it contain the Laboratory courses as at present?

2.14. What should be the division of laboratory time as between Laboratory for special course and general laboratories?

2.15. There is a general complaint from the employers that the present polytechnic students are weak in drawing and that they have very little idea about modern drawing office techniques or about standard practices as envisaged by standard specifications. What are your suggestions for improving the standard?

III. Sandwich Courses·

3.1. Do you consider that Sandwich courses could be run successfully in all polytechnics in India? If not where could it be tried?

3.2. Which of the two types of Sandwich course given below would you consider more effective?

(a) Sandwich Course for regular students recreated by the Educational institution and allocated to different industrial establishments for practical training (Institution based)

(b) Sandwich course for regular trainees in the industry who are given time release to join a polytechnic for theoretical training (Industry based)

3.3. What should be the type of Sandwich you would advocate—a thin layer or a thick layer.

3.4. Should the theoretical curriculum for Sandwich courses be tailored to suit the types of training in industrial establishments or should it be broad based?

For instance in Durgapur where there are Steel Industry, Optical Glass Works, Coke Ovens, Fertilizer Factory, Machine Tool Industry, Boiler Making, Electrical Machines, Electronic Industry—should a polytechnic run specialized courses in all these branches to cater for comparatively small number of students in each specialization or should it run general basic courses in Mechanical, Electrical, Civil, Chemical and Met? If you agree what will be your suggestions about institutional set up?

3.5. Should the Institution conduct basic workshop training to these students?

3.6. Would you advocate appointment of part-time lecturers from industry?

IV. In-plant Training

4.1. Is "In-plant training" necessary for proper training of technicians?

4.2. Is "In-plant training" as at present available, useful or desirable?

4.3. In case you feel that in-plant training is necessary but is not useful in its present form what would be your suggestions to make it effective?

4.4. What role can educational institution play to make in-plant training really effective?

4.5. How do you propose to plan, organise and supervise in-plant training?

4.6. How would you make in-plant training and specialized courses in institute complimentary to each other?

4.7. Do you feel that "a period of compulsory in-plant training" should form an integral part of Diploma education and that successful completion of this training should be a precondition to award of diploma?

4.8. If it to be a precondition, it will be necessary to find suitable placements in industry for all students and to provide adequate subsistance allowance, hostel accommodation etc. for all of them. Do you think that this is feasible proposition or does it pose unseen mountable problems, and make the scheme unworkable?

V. Educational System

5.1. Do you advocate annual sessional or semester system?

5.2. It is complained that the method of teaching followed at present is based on lectures and does not provide for any tutorial, seminar, follow up or continuous assessment.

Do you consider the introduction of tutorial and progressive assessment of students essential for better education?

5.3. If yes, should any weightage be given to tutorial work or assessment in the way of marks, credits etc. If yes, what should be the percentage of this credit?

5.4. Do you consider a final examination at the end of a semester, session or year necessary, in addition to assessment as envisaged in Q. 2.?

5.5. What should be the marks or credit assigned to the examination? Do you envisage any difficulty in the way of introduction of these systems and methods suggested in Q.1 to Q. 3 above?

What are they?

5.6. In case you do not find anything intrinsically unsound in the present system—do you feel that some changes major or minor in the present educational and examination system could be introduced with advantages?

If yes, suggest such changes as you consider necessary.

VI. Duration of Courses

6.1. Do you agree with the suggestion that the present duration of diploma courses *viz.* 3 years in the institution without practical training in industry is too short for any realistic and useful training acceptable to the industry?

6.2. What, in your opinion, should be broad distribution of available time (in number of hours as also percentage) between.

- (a) Theory or lecture classes including tutorials
- (b) Laboratory courses
- (c) Institutional workshop training.

6.3. What should be duration of practical training in industry?

Do you feel that the duration of diploma training should be uniform for all courses or should it depend on the subject of specialization or nature of course?

6.4. Do you consider it possible to vary the duration of training in an institution with varying admission qualifications *viz.* Higher Secondary with Science and Mathematics, Higher Secondary with Technical subjects, a pass in Junior Technical School, final I.T.I. training with trade specialization and with School Final Examination. If you agree, what would be your concrete suggestion regarding course structure *viz.* preparatory course, Basic training specialized training etc.?

VII. Miscellaneous

7.1. Do you think that there is need for study of humanities and social sciences in polytechnics?

7.2. As the products of the polytechnics will be employed as first line supervisory staff. Do you consider it necessary that they should have good command over the language and should develop power of communication?

If you agree please suggest course block to be incorporated in the curriculum with time involved.

7.3. Should you advocate inclusion of courses, group discussions or seminars on subjects such as

- (a) Managerial functions
- (b) Safety practices.

7.4. What are your view about the importance of co-curricular and extra mural activities in polytechnic education?

RESPONSES TO QUESTIONNAIRE SENT TO POLYTECHNICS IN INDIA

Summary of Findings*

I. PRESENT SYLLABUS AND CURRICULUM

The opinion that the present syllabus and curriculum is not suitable for present day requirements of the industry is significant.

Specific changes that are suggested to make the course more useful are many but only two of them *viz.*, (1) the course should be industry/job/field problem oriented, and (2) the course should have a practical bias are more frequently uttered.

Though opinion is almost equally divided between modifying the present curriculum and recasting it completely, there is indication that demand for change moderate or complete, is universal.

This general demand for change has come out as a desire (1) to make the course broadbased throughout, (2) to start on a broadbase and go diversification and specialization as students more from year to year or Semester to Semester in a course, and (3) to start diversification even from the beginning. The opinion is more in favour of diversification from the beginning. But this point of view is contradicted immediately in the next response where diversification and specialization is liked to be superimposed on a scientific broadbased instead of having it from the very beginning. This would mean that a high majority of respondents demand diversification and specialization as a must but super-imposed on a broadbase.

Of course, diversification and specialization should be technology oriented as per the wishes of most respondents.

Basic Sciences in technician courses should serve the purposes they are intended to *i.e.* applied content, and a minimum of them is considered sufficient. The opinions that the present content is adequate is also prominent.

More than 150 new courses are asked for by the respondents of which the need for "electronics, automobile engineering refrigeration agricultural engineering, architecture and town planning, production technology, instrumentation and control, telecommunication, chemical engineering, foundry engineering, irrigation, tool making, public health engineering, construction technology, agro-industries, radio engineering, marine engineering, structural engineering, welding and metallurgical engineering" appears signivcant.

Many of the respondents accept the proposition that small and independent project work on design, construction and testing is necessary for students to do at the final stages of institutional training.

II. WORKSHOP, LABORATORY AND DRAWING COURSES

The model demand of time for workshop training is 11—20 per cent, whereas it is 16—20 per cent for Laboratory and Drawing courses. Where a total time for all the three together is demanded it is 41—50 per cent. The average time demand stands somewhere around 15 per cent for each.

Half the number of respondents feel that present allotment of time is satisfactory which the other half are of a different opinion and the demand for increase in time for all the three is significant.

Many want a change in the curriculum without recommending anything specific here and some want it to be more practical oriented. Again regarding training methods in the institution the opinion is in favour of making it industry/job oriented.

The majority opinion is in favour of making workshop training extensive and repetitive. There is no clear consensus of opinion whether to leave the task of final training in the line of specialization to the industries concerned but about general workshop training a high majority feels that it should not be left with the industry. Of course a fraction of this majority allows the industry to do a part of it wherever necessary.

In the case of keeping training with the institution, opinion is very significantly in favour of making it diversified to suit the needs of different fields of training.

General suggestions for all the eleven industries named include (1) the collection of opinion from industries, (2) general basic workshop training in them, and (4) training in industries. For (1) heavy mechanical engineering respondents prefer (a) to gather opinion from the industry, (b) machine shop and tool room practices. For (3) light electrical, electronic industries repair and maintenance is the prominent response; for (5) structural engineering, welding technology, fabrication and design are significant responses; for (7) instruments again repair and maintenance is the significant response, as also for (8) agro-industries and (9) automobile industry. Among the responses for (2) heavy electrical industries, winding approaches significance also for (3) light electrical, electronic industries wiring and soldering, and for (4) repair and maintenance approach significance, for (6) irrigation, for (10) textile and for (11) chemical engineering no response appears significance. Taking all the 11 categories together it appears that repair and maintenance can become a significant demand.

Except for minor changes in equipment, administration, maintenance and repair of equipment, the opinion significantly appears to be that present workshop equipment is adequate for imparting basic training or the kind of training suggested by respondents. No common suggestion is forthcoming from those who consider that the present equipment is inadequate.

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*These summaries are based on data available in the tables in Appendix I.

Laboratory courses, as at present followed, appear useful to a significant number of respondents. Yet most of them agree to have the courses built round all the five *viz.* (a) measurement of basic parameters, (b) setting up of appratus, (c) dismanting & erection of machines, (d) testing of machines and apparatus for their performance, and (e) trouble-shooting. The suggestion to have all these courses in the laboratory is significant while they recommend steps to reorganize the laboratory set-up. Othr significant recommendation include that (1) there is no need to change the present set-up, (2) equipment for training assembly and dismantling and (3) more equipment are to be acquired.

Opinion is divided between having the laboratory course centre round specialized courses and keeping it as it is now. Again opinion does not crystallige either for more emphasis on special laboratories or for general laboratories.

The most significant suggestion to improve the standard of drawing is to improve teachers and their techniques of teaching. Other significant suggestions include (a) provision of modern drawing office techniques, (b) utilizing ISI standards and (c) teaching through models and other visual aids.

III. SANDWICH COURSES

The feeling that Sandwich courses could not be run successful in all polytechnics is very significant and the opinion that they can be run (1) where a large number of industries are available and (2) in Polytechnics situated near industrial townships is prominent.

Opinion in choosing Sandwich Courses is divided between regular studies from the institute going to the industry and regular trainees from the industry attending the institute. Again opinion is almost equally divided between a thin layer and a thick layer type of Sandwich Course.

The theoretical curriculum should be broadbased and it should not be tailored to suit the types of training in industrial establishments is the significant opinion of respondents. So no clear suggestion has come up to organize the polytechnic set-up.

Basic workshop training is demanded to be given by the institute by a majority of respondents and a still higher majority agrees to have part-time lectures from the industry to teach in polytechnic.

IV. IN-PLANT TRAINING

Most of the respondents think that in-plant training is necessary for the proper training of technicians. Many find that it is not available now but highly desirable in polytechnic education. Opinion is divided as to what is obtained as in-plant training now is useful or not.

The suggestions to make in-plant training useful include (1) that supervision of in-plant training by staff is necessary and (2) that there should be a training officer in polytechnics for organizing in-plant training.

"Provide supervision by institute staff" and "improve institute-industry contact and collaboration" are the stock answer to queries on the role of educational institutions in making in-plant training effective and on the manner in which the institution can plan, organize and supervise it. Again, in order to make in-plant training and specialized courses in the institute complementary, the main suggestion is institute—industry co-operation and the next one is provision facilities in industries for training students in electives.

A high majority feels that a period of compulsory in-plant training should form an integral part of Diploma education and the successful completion of this training should be a precondition to award a diploma. Many feel that in-plant training will be feasible if suitable placements in industry for all students can be made and other amenities like subsistence allowance, hostel accommodation etc., are provided.

V. EDUCATIONAL SYSTEM

Respondents are in favour of the Semester system. Almost all of them consider that the introduction of tutorials and progressive assessment of students are essential for better educatien.

The model response is that 50 per cent of total marks should be assigned to tutorials and progressive assessment in the evaluation of student performance.

Of course, most of the respondents consider that a final examination at the end of a Semester, session or year is necessary. It should have 50 per cent credit in marks or grades in the final evaluation.

Many of the respondents feel that there will be no difficulty in introducing the new system of evaluation.

Regarding opinion about anything unsound in the present system, it appears that many feel that a change is necessary; some others think that the present is alright; and a further few consider that the instroduction of the Semester system will do good to diploma education.

VI. DURATION OF COURSES

There is no clear opinion about the duration of existing diploma courses as to whether it is too short for any realistic and useful training acceptable to the industry.

About 40-50 per cent of the total time or about 20 hours per week appears to be the modal demand for the theory and lecture classes including tutorials. The demand is for 20-30 per cent only of total time or 6 hours a week, for laboratory courses, and again 20-30 per cent of total time or 6-9 hours a week for workshop training—as can be seen from the modal responses to these questionnarie items. Though the respondents were not asked about the time they need for Drawing, many of them have suggested 6 hours for it in the weekly routine.

Many consider that a period of one year of practical training in the industry will be proper, and almost an equal number think that six months will be alright. Suggestions include that the practical training in the industry need not be at a stretch.

Opinion is fairly equally divided between keeping the same duration for all courses and having different durations for different subjects depending on the subject of specialization or nature of course.

The majority opinion is that the duration of training in an institution with having admission qualifications should be uniform and it cannot be varied. This opinion is significant. If at all course duration is to be varied depending on admission qualifications, the only significant suggestion is that students with higher qualifications can be allowed to strip certain basic content and perhaps save a Semester or so.

Opinion about the need for the study of humanities is divided but it approaches significance in favour of having humanities in diploma education. At the same time the demand that polytechnic diplomates should have command over language and develop power of communication is significant. The only significant suggestion here is that language study should be made compulsory in diploma education.

Most of the respondents think that courses, group discussions, and seminars on managerial functions and safety practices will be useful.

Regarding their views about co-curricular and extra-mural activities in polytechnic education, respondeents feel that they should be encouraged, and they are necessary, even essential, as well as desirable.

APPENDIX VI

Illustrative Curriculum Outlines

The following curriculum outlines are given for purposes of illustrating how, within the general guidelines of Chapter V, curricula may be framed for diversified full-time, sandwich and part-time diploma courses. They are not intended as standard ones or as models to be uniformly followed. Diversification, or specialisation in a limited range of sub-fields of a major branch, is provided through 4 elective subjects to be chosen from among any of a number of groups. The 4 electives represent 360 theory hours in a total of about 1800 hours of theory in a full time course. The remaining 1440 theory hours (or 80 per cent) which are common to all the diversifications are allotted to subjects which form the broad base common to the entire branch.

Neither the titles of the diversifications nor the elective subjects are intended to be taken as standard ones or the only possible ones. Other and different electives and different groupings are possible and will indeed be necessary in accordance with the changing needs and situations of different polytechnics. The only guide line is that in framing a group of electives narrow specialisation should be avoided.

As for the subjects forming the broad base namely the General Studies, Science and Applied Science Subjects, and Technical Studies (other than electives) while some rearrangements are possible with reference to the number and titles of individual subjects and the times allotted to each subject and its location in the three year period, their overall content is less likely to be inflenced by local needs or conditions. The syllabi of individual subjects and their levels and orientation may of course be framed differently in different polytechnics.

Likewise a major part of the General Studies and Science and Applied Science Subjects will be found to be common to all the branches. The specific contents of these subjects may be framed to suit the needs of each branch and specialisation.

About 40 per cent of the total curricular time in a full-time course is allotted to practice, a substantial part of which being devoted to the field of diversification. This allocation could vary within certain limits depending on the nature of the branch and diversification.

Project work has been given due emphasis in all the outlines.

The durations of the courses are assumed as follows, which represent the basic minima:

Full-time course: 3 Years: 3000 contact hours (at 1000 hours per year).

Sandwich course: 3 1|2 Yrs.: 3500 hours (at 1000 hours per year) of which 1000 form In-Plant-Training.

Part-time course: 4 Years: 1800 hours (at 450 hours per year).

In the sandwich courses, while the theory subjects and time allotted to them remain nearly the same as in the full-time course, there is a considerable reduction in the time allotted to practice within the institution. Institutional practical work in this case will cover only such of the specialised laboratory and design drawing work as well as the basic workshop training which cannot be generally arranged under Industrial Training. Variations in the practical content are therefore to be expected depending on the kind of industrial training facilities available. The arrangement of the sandwich periods and their number and duration will depend entirely on local conditions in respect of industrial training and therefore the outlines do not specify any particular sequence or duration of individual sandwich layers. Project work in the case of sandwich courses should be done partly in the institution and partly in the industry.

As in Sandwich courses, in part-time degree courses also, the theory subjects remain more or less the same as in the full-time courses; however since the student is expected to be mature and is in any case exposed to much of the technology in his day to day work, the number of hours he needs to get instruction in any subject is much less than for a full-time student. Similarly much of the descriptive portions of the technical subjects could be cut out. These considerations have been taken into account in fixing the time allotment for each subject. The practical work in the part-time course is restricted to such of the areas which normally do not form part of the work of the student in his work situation.

CIVIL ENGINEERING : 3 YEAR FULL—TIME COURSE

(Diversification through electives)

Kind of subjects and total allotted hours.	Subjects	Contact Hours per year I Year	 II Year	 III Year
GS	English	100		
300 (10%)	Humanities, Management and Administration		100	100
SAS	Applied Mathematics	120		
510	Applied Sciences	90	..	..
(17%)	Engineering Mechanics	90		
	Science Lab.	120		
	Applied Mechanics and Graphic Statics			90
	Electrical and Mechanical Technology	90		
	Geotechnique—I	90		
	Geotechnique—II		60	
TS 990 (33%)	Construction Materials and Practice		90	
	Structural Design Fundamentals		60	
	Hydraulic Engineering	..	60	
	Elective—I	..	90	
	Transportation Engineering	..	..	90
	Quantity Surveying, Contracts Specifications	..	..	90
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Engineering Drawing	180	..	..
	Workshop Practice	120	..	..
	Civil Engineering Drawing	..	120	
P	Structural Design & Drawing	..	120	..
1200	Geotechnique Lab/Practice	..	120	..
(40%)	Materials & Structures Lab.	..	90	
	Elective Design, Drawing/Office	..	..	120
	Elective Lab/Practice	..	..	120
	Hydraulic & Electrical Lab.	..	..	90
	Project Work	..	..	120
3000 (100%)	TOTAL	1000	1000	1000

GS . . . General Studies
SAS . . . Science and Applied Science Subjects
TS . . . Technical Studies
P . Practice

CIVIL ENGINEERING : 3 1/2 YEAR SANDWICH COURSE

Kind of subjects and total allotted hours	Subjects	Institutional contact hours		
		I Year	II Session	III* Session
GS 280 8%)	English	100	..	..
	Humanities, Management and Administration	..	90	90
SAS 510 (14·6%)	Applied Mathematics	120	..	..
	Applied Sciences	90	..	..
	Engineering Mechanics	90	..	..
	Science Lab.	120	..	..
	Applied Mechanics and Graphic Statics	..	90	..
TS 930 (26·6%)	Electrical and Mechanical Technology	90	..	..
	Geotechnique—I	90	..	..
	Geotechnique—II	..	60	..
	Construction Materials and Practice	..	60	..
	Structural Design Fundamentals	..	60	..
	Hydraulic Engineering		60	..
	Elective—I	..	90	
	Transportation Engineering	..	..	90
	Quantity Surveying, Contracts Specifications	..	..	60
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
P 780 (22·3%)	Engineering Drawing	180	..	..
	Workshop Practice	120	..	..
	Civil Engineering Drawing	..	60	..
	Structural Design & Drawing	..	60	..
	Geotechnique Lab/Practice	..	60	..
	Materials & Structures Lab.	..	60	..
	Elective Design, Drawing Office Lab.	..	..	90
	Hydraulic & Electrical Lab.	..	..	60
	Project Work	..	..	90
1000 (28·5%) IN-PLANT TRAINING**				
3500 (100%)	TOTAL	1000	750	750

GS . . . . General Studies
SAS . . . . Science and Applied Science Subjects
TS . Technical Studies
P . . . . Practice
* . Students should spend the last term of the course for a period of not less than 3 months, in the institution
** . . . . IN-PLANT TRAINING may be suitably sandwiched and the number of sessions decided in accordance with local conditions.

CIVIL ENGINEERING : 4-YEAR PART-TIME COURSE

Kind of subjects and total allotted hours.	Subjects	Contact hours per year			
		I Year	II Year	III Year	IV Year
GS	English	90	..	..	..
270	Humanities, Management and Administration	..	..	90	90
SAS	Applied Mathematics	90	..	..	..
360	Applied Sciences	90	..	..	..
(20%)	Engineering Mechanics	90	..	..	..
	Applied Mechanics and Graphics Statics	..	90	..	..
	Electrical and Mechanical Technology	..	60	..	..
	Geotechnique—I	..	60	..	..
	Geotechnique—II	..	..	60	..
TS	Construction Materials and Practice	..	60	..	..
720	Structural Design Fundamentals	..	60	..	..
(40%)	Hydraulic Engineering	..	..	60	..
	Elective—I	..	..	60	..
	Transportation Engineering	..	..	60	..
	Quantity Surveying, Contracts, Specifications	..	..	60	..
	Elective—II	..	..	..	60
	Elective—III	..	..	..	60
	Elective—IV		..	..	60
	Civil Engineering Drawing	90	..	..	..
	Structural Design & Drawing	..	60	..	..
P	Materials and Structures Lab.	..	60	..	..
450	Electrical & Hydraulic Lab.	..	..	60	..
(25%)	Elective Design, Drawing/Office/Lab.	..	..	..	90
	Project Work	..	..	..	90
oo (100%)	TOTAL	450	450	450	450

GS . General Studies
SAS . . . Science and Applied Science Subjects
TS . Technical Studies
P . . . Practice

ELECTIVES (CIVIL ENGINEERING)

(Four electives should be chosen under any one of the diversifications)

Diversification : *Building Technology*

1. Building Services
2. Building Planning and Design
3. Building Construction Engineering
4. Structural Design and Detailing
5. Specifications, Standards, Codes, Byelaws, Rules and Regulations
6. Concrete Constrution and Technology

Diversification : *Architecture & Building Construction*

1. Architecture
2. Archiectural Materials
3. Functional Design of Buildings
4. Architectural Construction & Building Services
5. Structural Design and Detailing
6. Specifications, Standards, Codes, Byelaws, Rules and Regulations.

Diversification : *Public Health & Municipal Engineering*

1. Ground Water Engineering
2. Water Supply Engineering and Practice
3. Waste Water Engineering and Sewerage Practice
4. Plumbing, Heating and ventilation
5. Water supply and Sanitary Engineering Structures
6. Specifications, Standards, Codes, Byelaws, Rules and Regulations.

Diversification : *Construction Technology*

1. Construction Materials and Quality Control
2. Construction Plant and Equipment
3. Construction Management
4. Construction Methods
5. Quantity Surveying, Estimating, Specifications
6. Structural Design and Detailing

Some of the other diversifications which could be offered through suitable electives are :

(*i*) Under-Water Structures

(*ii*) Soil Engineering

(*iii*) Bridge Engineering

ELECTRICAL ENGINEERING : 3-YEAR FULL-TIME COURSE

(Diversification through electives)

Kind of subjects and total allotted hours	Subjects	Contact hours per year		
		I Year	II Year	III Year
GS	English	100	..	..
300 (10%)	Humanities, Management and Administration	..	100	100
	Applied Mathematics	120	..	..
	Applied Sciences	90	..	..
SAS	Engineering Mechanics	90	..	..
690	Electrical and Magnetic Circuits—I	90	..	..
(23%)	Electrical and Magnetic Circuits—II	..	90	..
	Electrical Engg. Mathematics	..	90	..
	Science Lab	120	..	..
	General Engineering	90	..	..
	Elec. Engg. Materials	..	90	..
	General Elec. Engineering	..	120	..
TS	Fabrication Techniques	..	..	90
840	Elec. Measurements	..	..	90
(28%)	Elective—I	..	90	..
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Engineering Drawing	180	..	..
	Workshop Practice—I	120	..	..
	Workshop Practice—II	..	120	..
P	Electrical Lab.	..	150	
1170	Design and Drawing—I	..	150	..
(39%)	Design and Drawing—II	..	..	150
	Elective Lab.	..	..	150
	Project Work	..	..	150
3000 (100%)	TOTAL	1000	1000	1000

GS . . . General Studies
SAS . . . Science and Applied Science Subjects
TS . . . Technical Studies
P . . . Practice

ELECTRICAL ENGINEERING : 3 1/2 YEAR SANDWICH COURSE

Kind of subjects and total allotted hours	Subjects	Institutional contact hours		
		I Year	II Session/III* Session	
GS 280 (8%)	English	100	..	..
	Humanities, Management and Administration		90	90
	Applied Mathematics	120	..	..
	Applied Sciences	90	..	..
SAS	Engineering Mechanics	90	..	..
690	Electrical and Magnetic Circuits—I	90	..	..
(20%)	Electrical and Magnetic Circuits—II	..	90	..
	Elec. Engg. Mathematics	..	90	..
	Science Lab.	120	..	..
	General Engineering	90	..	..
	Elec. Engg. Materials	..	90	..
	General Elec. Engineering	..	90	..
TS	Fabrication Techniques	..	..	60
780	Elec. Measurements	..	..	90
(22%)	Elective—I	90	..	..
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Engineering Drawing	180	..	..
	Workshop Practice]	120	..	..
P	Electrical Lab.	..	90	..
750	Design and Drawing—I	..	120	..
(21·5%)	Design and Drawing—II	..	..	90
	Elective Lab.	..	..	60
	Project Work	..	..	90
1000 (28·5%)	IN-PLANT TRAINING**			
3500 (100%)	TOTAL	1000	750	750

GS	General Studies
SAS	Science and Applied Science Subjects
TS	Technical Studies
P	Practice
*	Students should spend the last term of the course, for a period of not less than 3 months, in the institution.
**	IN-PLANT TRAINING may be suitably sandwiched and the number of sessions decided in accordance with local conditions.

ELECTRICAL ENGINEERING : 4 YEAR PART-TIME COURSE

Kind of subjects and total allotted hours	Subjects	Contact hours per year			
		I Yr.	II Yr.	III Yr	IV Yr.
GS	English	90	..	..	..
270 (15%)	Humanities. Management and Administration	..	..	90	90
	Applied Mathematics	90	..	..	..
	Applied Sciences	90	..	..	..
SAS	Engineering Mechanics	90	..	..	..
540	Electrical and Magnetic Circuits—I	..	90	..	..
(30%)	Electrical and Magnetic Circuits—II	..	90	..	..
	Elec. Engg. Mathematics	..	90	..	..
	Elec. Engg. Materials	..	90	..	..
	General Elec. Engineering	..	..	90	..
	Fabrication Techniques	..	..	60	..
TS	Elec. Measurements	..	..	60	..
540	Elective—I	..	..	60	..
(30%)	Elective—II	..	..	..	60
	Elective—III	..	..	..	60
	Elective—IV	..	..	..	60
	Engineering Drawing	90	..	..	..
P	Electrical Lab.	..	90	..	..
450	Design and Drawing—I	..	..	90	..
(25%)	Design and Drawing—II & Elective Lab.	..	..	..	90
	Project Work	..	..	..	90
1800 (100%)	TOTAL	450	450	450	450

GS . . . . General Studies
SAS . . . . Science and Applied Science Subjects
TS . Technical Studies
P . . . . Practice

ELECTIVES (ELECTRICAL ENGINEERING)

(Four electives should be chosen under any one of the diversification)

Diversification: Industrial and Applied Electronics

1. Electrical Measurements and Instrumentation
2. Applied and Industrial Electronics
3. Semiconductor Devices and Applications.
4. Relay Devices.
5. Operation and Maintenance of Electrical Apparatus.
6. Computers and Applications.

Diversification: Power System Engineering

1. D.C. and A.C. Machines.
2. Transmission and Distribution.
3. Generation, Protection and Switchgear, Economics.
4. Utilization of Electrical Energy.
5. Power System Analysis and Carrier Communication.
6. Operation and Maintenance of Electrical Apparatus.

Diversification: Electrical Machine Manufacture

1. D.C. and A.C. Machines.
2. Prime Movers.
3. Design of Electrical Machines.
4. Manufacturing Engineering.
5. Operation and Maintenance of Electrical Apparatus.
6. Production Technology.

Diversification: Industrial Drives and Controls

1. D.C. and A.C. Machines.
2. Electronics Principles and Circuits and Applied Electronics.
3. Principles of Feedback Control and Control System Components.
4. Electric Machinery Control.
5. Electrical Measurements and Instrumentation.
6. Utilization of Electrical Energy.

Diversification: Communication Engineering

1. Networks, Lines and Fields
2. Communication Engineering.
3. Electronics Principles and Circuits and Semiconductor Devices and Applications.
4. Microwave Engineering.
5. Antennas.
6. Radio, Radar, and Television Engineering.

Some of the other diversifications which could be offered through suitable electives are:

(i) Bio-Medical Electronics.
(ii) Computer Technology.

MECHANICAL ENGINEERING : 3 YEAR FULL-TIME COURSE

(Diversification through electives)

Kind of subjects and total allotted hours	Subjects	Contact hours per year		
		I Yr.	II Yr.	III Yr.
GS	English	100	..	..
300 (10%)	Humanities, Management and Administration	..	100	100
	Applied Mathematics	120	..	..
SAS	Applied Sciences	90	..	..
510	Engineering Mechanics	90	..	..
(17%)	Science Lab.	120	..	..
	Applied Thermodynamics	..	90	..
	General Engineering	90	..	..
	Electrical Technology	90	..	..
	Metrology & Quality Control	..	90	..
TS	Manufacturing Tech.—I	..	60	..
990	Manufacturing Tech.—II	..	..	90
(33%)	Metallurgy and Materials	..	60	..
	Mechanics of Machines	..	60	..
	Elective—I	..	90	..
	Plant Engineering	..	..	90
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Engineering Drawing	180	..	..
	Workshop Practice—I	120	..	..
	Workshop Practice—II	..	150	..
P.	Workshop Practice—II	..	..	120
1200	Design and Drawing—I	..	150	..
(40%)	Design and Drawing—II	..	..	120
	Electrical & Mechanical Lab.	..	150	..
	Elective Lab.	..	..	90
	Project Work	..	..	120
3000 (100%)	TOTAL	1000	1000	1000

GS . . . General Studies
SAS . . . Science and Applied Science Subjects
TS . . . Technical Studies
P . . . Practice

MECHANICAL ENGINEERING : 3 1/2 YEAR SANDWICH COURSE

Kind of subjects and total allotted hours	Subject	Institutional contact hours		
		I Year	II Session	III* Session
GS	English	100	..	..
280 (8%)	Humanities, Mangement and Administration	..	90	90
	Applied Mathematics	120	..	..
SAS	Applied Sciences	90	..	..
510	Engineering Mechanics	90	..	..
(14·5%)	Science Lab.	120	..	..
	Applied Thermodynamics	..	90	..
	General Engineering	90	..	..
	Electrical Technology	90	..	..
	Metrology and Quality Control	..	90	..
	Manufacturing Tech.—I	..	60	..
	Manufacturing Tech.—II	..	..	60
	Metallurgy and Materials	..	60	..
	Mechanics and Machines	..	60	..
	Elective—I	..	90	..
	Plant Engineering	..	..	90
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Engineering Drawing	180	..	..
	Workshop Practice	120	..	..
	Design and Drawing—I	..	120	..
750	Design and Drawing—II	..	..	90
(21·5%)	Electrical & Mechanical Lab.	..	90	..
	Elective Lab.	..	..	60
	Project Work	..	..	90
1000(28·5%) IN-PLANT TRAINING **				
3500 (100%)	TOTAL	1000	750	750

GS . . . General Studies
SAS . . . Science and Applied Science Subjects
TS . Technical Studies
P . . . Practice
* . Students must spend the last term of the course, for a period of not less than 3 months. in the instituion.
** . . . IN-PLANT TRAINING may be suitably sandwiched and the number of sessions decided in accordance with local conditions.

MECHANICAL ENGINEERING: 4 YEAR PART-TIME COURSE

Kind of subjects and total allotted hours.	Subjects	Contact hours per year			
		I Yr.	II Yr.	III Yr.	IV Yr.
GS 270 (15%)	English	90	..	..	..
	Humanities, Management and Administration	..	..	90	90
SAS 360 (20%)	Applied Mathematics	90	..	..	..
	Applied Sciences	90	..	..	..
	Engineering Mechanics	90	..	..	..
	Applied Thermodynamics	..	90	..	..
TS 720 (40%)	Electrical Technology	..	90	..	..
	Metrology and Quality Control	..	60	..	..
	Manufacturing Technology—I	..	60	..	..
	Manufacturing Technology—II	..	..	60	..
	Metallurgy and Materials	..	60	..	..
	Mechanics of Machines	..	..	60	..
	Plant Engineering	..	..	90	..
	Elective—I	..	..	60	..
	Elective—II	..	..	..	60
	Elective—III	..	..	..	60
	Elective—IV	..	..	..	60
P 450 (25%)	Engineering Drawing	90	..	..	..
	Electrical & Mechanical Lab.	..	90	..	..
	Design and Drawing—I	..	..	90	..
	Design and Drawing—II	..	..	..	90
	Project Work	..	..	..	90
1800 (100%)	TOTAL	450	450	450	450

GS	General Stuides
SAS	Science and Applied Science Subjects
TS	Technical Studies
P	Practice

ELECTIVES (MECHANICAL ENGINEERING)

(Four electives should be chosen under any one of the diversification)

Diversification: Production Engineering

1. Metal Forming Processes
2. Tool Engineering.
3. Newer Machining Processes
4. Jigs and Fixtures.
5. Production Planning and Control
6. Heat Treatment of Metals and Alloys

Diversification: Welding Technology

1. Welding Processes
2. Design and Testing of Weldments
3. Newer Welding Techniques
4. Welding Metallurgy
5. Welding Equipment and Machines
6. Heat Treatment of Metals and Alloys

Diversification: Foundry Technology

1. Foundry Processes and Materials
2. Foundry Equipments and Mechanisation
3. Design for Casting
4. Foundry Metallurgy
5. Testing and Inspection of Castings
6. Heat Treatment of Metals and Alloys

Diversification: Machine Tool Technology

1. Metal Forming Processes
2. Tool Engineering
3. Automats, Transfer Lines and N|C Machines
4. Jigs and Fixtures
5. Heat Treatment of Metals and Alloys

Diversification: Heat Power Engineering

1. Refrigeration Engineering
2. Air-Conditioning Engineering
3. Fans, Blowers and Compressors
4. Boilers, Auxiliaries, Accessories & Mountings
5. Fuels and Combustion

Diversification: Industrial Engineering

1. Work Study
2. Production Control and Material Management
3. Plant Layout, Materials Handling and Industrial Safety
4. Statistics and Introduction to Operations Research
5. Personnel Management
6. Cost Accounting and Industrial Economics

Diversification: Agricultural Engineering

1. Tractors and Engines
2. Agricultural Machinery
3. Farm Mechanisation
4. Hydrology, Irrigation and Hydrotechnical Equipment
5. Soil Conservation
6. Agricultural Economics and Management

Diversification: Metallurgical Engineering

1. Foundry Metallurgy
2. Welding Metallurgy
3. Heat Treatment of Metals and Alloys
4. Powder Metallurgy
5. Electrometallurgy and Corrosion
6. Mechanical Metallurgy
7. Ferrous and Non-Ferrous Production Metullurgy

Some of the other diversifications which could be offered through suitable electives are

(i) Rocket & Jet Propulsion Technology
(ii) Hospital Technology
(iii) Air-Craft Engineering
(iv) Ship-Building Engineering

TEXTILE TECHNOLOGY : 3 YEAR FULL-TIME COURSE

(Diversification through electives)

Kind of subjects and total allotted hours.	Subjects	Contact hours per year		
		I Yr.	II Yr.	III Yr.
GS 300 (10%)	English	100	..	..
	Humanities, Management and Administration	..	100	100
SAS 510 (17%)	Applied Mathematics	120	..	..
	Applied Sciences	90	..	..
	Engineering Mechanics	90	..	..
	Physics and Chemistry of fibre	..	90	..
	Science Lab.	120	..	
TS 990 (33%)	Mechanical Engineering	90	..	..
	General Textile Technology	90	..	..
	Electrical Technology	..	90	..
	Technology of Spinning	..	90	..
	Technology of Weaving	..	90	..
	Textile Testing	..	..	90
	Elective I	..	90	..
	Dyeing, Bleaching, Printing and Finishing	..	..	90
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
P 1200 (40%)	Engineering Drawing	180	..	..
	Textile and Engineering Workshop Practice	120	..	..
	Spinning Workshop		150	..
	Weaving Workshop	..	150	..
	Textile Testing and Dyeing Lab-I	..	150	..
	Elective Lab.	..	..	150
	Textile Testing and Dyeing Lab-II	..	..	150
	Project work	..	..	150
3000 (100%)	TOTAL	1000	1000	1000

GS	General Studies
SAS	Science and Applied Sciences Subjects
TS	Technical Studies
P	Practice.

TEXTILE TECHNOLOGY : 3½ YEAR SANDWICH COURSE

Kind of subjects and total allotted hours	Subjects	Institutional contact hours		
		I Year	II Session	III* Session
GS 280 (8%)	English	100	..	..
	Humanities, Management and Administration	..	90	90
SAS 510 (14·6%)	Applied Mathematics	120	..	..
	Applied Sciences	90	..	..
	Engineering Mechanics	90	..	..
	Physics and Chemistry of Fibres	..	90	..
	Science Lab.	120	..	..
TS 990 (28·39%)	Mechanical Engineering	90	..	..
	General Textile Technology	90	..	..
	Electrical Technology	..	90	..
	Technology of Spinning	..	90	..
	Technology of Weaving	..	90	..
	Textile Teting	..	..	90
	Elective—I	..	90	..
	Dyeing, Bleaching, Printing and Finishing	..	..	90
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
P 720 (20·5%)	Engineering Drawing	180	..	..
	Textile and Engineering Workshop Practice	120	..	..
	Spinning Workshop and Weaving Workshop	..	90	..
	Textile Testing and Dyeing Lab.	..	120	..
	Elective Lab.	..	..	120
	Project Work	..	..	90
1000 (28·6%)	IN-PLANT TRAINING**			
3500 (100%)	TOTAL	1000	750	750

GS	General Studies
SAS	Science and Applied Science Subjects
TS	Technical Studies
P	Practice
*	Students must spend the last term of the course, for a period of not less than 3 months, in the institution.
**	IN-PLANT TRAINING may be suitably sandwiched and the number of sessions decided in accordance with local conditions.

TEXTILE TECHNOLOGY : 4 YEAR PART-TIME COURSE

Kind of subjects and total allotted hours	Subjects	Contact hours per year			
		I Year	II Year	III Year	IV Year
GS 270 (15%)	English	90	..	..	..
	Humanities, Management and Administration	..	..	90	90
SAS 360 (20 %)	Applied Mathematics	90	..	..	..
	Applied Sciences	90	..	..	..
	Engineering Mechanics	90	..	..	..
	Physics and Chemistry of Fibres	..	90	..	..
TS 780 (43·3%)	Mechanical Engineering	..	90	..	..
	General Textile Technology	..	60	..	..
	Electrical Technology	..	90	..	..
	Technology of Spinning	..	60	..	..
	Technology of Weaving	..	60	..	..
	Textile Testing	..	..	90	..
	Elective—I	..	..	60	..
	Dyeing, Bleaching, Printing and Finishing	..	..	90	..
	Elective—II	..	..	..	60
	Elective—III	..	..	..	60
	Elective—IV	..	..	..	60
P 390 (21·7%)	Engineering Drawing	90	..	..	..
	Textile Testing and Dyeing Lab.	..	..	120	..
	Elective Lab.	..	..	..	90
	Project work	..	..	..	90
1800 (100%)	TOTAL	450	450	450	450

GS . . . . General Studies
SAS . . . . Science and Applied Sciences Subjects
TS . . . . Technical Studies
P . . . . Practice.

ELECTIVES (TEXTILE TECHNOLOGY)

(Four electives should be chosen under any one of the diversifications)

DIVERCIFICATION : SPINNING

1. Preparatory Processes
2. Spinning of Cotton
3. Wool Spinning
4. Waste Cotton & Fancy Yarn Spinning
5. Spinning of blends
6. Man made fibre technology

Diversification : Weaving

1. Warp and Weft Preparation and Plain Looms
2. Loom Attachments & Automatic Weaving
3. Knitting Technology
4. Fabric Structure
5. Designing of Cloth
6. Unconventional Weaving and Weaving of Rayons and Synthetics
7. Uanufacture of Bonded Fabrics

Diversification : Wet Processing

1. Bleaching of Textiles
2. Dyeing & Printing of Textiles
3. Finishing of Cotton Yarn and Cloth
4. Finishing of blends
5. Chemistry of Silk & Wool
6. Chemistry of Starches, Dyes & Other Textile Auxiliaries

CHEMICAL ENGINEERING : 3 YEAR FULL-TIME COURSE

(Diversification through electives)

Kind of subjects and total allotted hours	Subjects	Contact hours per year		
		I Year	II Year	III Year
GS 300 (10%)	English	100	..	..
	Humanities, Management and Administration	..	100	100
SAS 660 (22%)	Applied Mathematics	120	..	..
	Industrial Chemistry—I	60	..	..
	Industrial Chemistry—II	..	90	..
	Physical Chemistry	90	..	..
	Applied Thermodynamics	..	90	..
	Engineering Mechanics	90	..	..
	Science Lab.	120	..	..
TS 840 (28 %)	Elec. Tech. & Electronics	60	..	..
	Hydraulic Engineering	60	..	..
	Heat & Mass Transfer	..	90	..
	Unit Chem. Engg. Operations and Processes-I		90	..
	-do- —II	..	..	90
	Elective—I	..	90	..
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Transport and Storage of Materials	..	..	90
P 1200 (40%)	Engineering Drawing	180	..	..
	Workshop Practice	120	..	..
	Design and Drawing—I	..	150	..
	Design and Drawing—II	..	..	150
	Chemical Engineering Lab.	..	150	..
	Electrical and Hydraulics Lab.	.	150	..
	Elective Lab.	..	..	150
	Project Work	..	..	150
3000 (100%)	TOTAL	1000	1000	1000

GS	General Sutides
SAS	Science and Applied Science Subjects
TS	**Technical Studies**
P	Practice

CHEMICAL ENGINEERING : 3½ YEAR SANDWICH COURSE

Kind of subjects and total allotted hours	Subjects	Institutional contact hours		
		I Year	II Session	III* Session
GS 280 (8%)	English	100	..	..
	Humanities: Management and Administration	..	90	90
S S 630 (18%)	Applied Mathematics	120	..	..
	Industrial Chemistry—I	60	..	..
	Industrial Chemistry—II	..	60	..
	Physical Chemistry	90	..	..
	Applied Thermodynamics	..	90	..
	Engineering Mechanics	90	..	..
	Science Lab.	120	..	..
TS 810 (23%)	Elec. Tech. & Electronics	60	..	..
	Hydraulic Enginneering	60	..	..
	Heat & Mass Transfer	..	90	..
	Unit Chem. Engineering Operations & Processe —I	..	90	..
	-do- —II	..	..	90
	Elective—I	..	90	..
	Elective—II	..	..	90
	Elective—III	..	..	90
	Elective—IV	..	..	90
	Transport and Storage of Materials	..	..	90
P 30 (22.5%)	Engineering Drawing	180	..	..
	Workshop Practice	120	..	..
	Design and Drawing—I	..	90	..
	Design and Drawing—II	..	..	90
	Chemical Engineering Lab.	..	60	..
	Electrical & Hydraulics Lab.	..	90	..
	Elective Lab.	..	..	60
	Project work	..	..	90
1000 (28.5%)	IN-PLANT TRAINING**			
3500 (100%)	TOTAL	1000	750	750

GS . . . General Studies
SAS . . . Science and Applied Science Subjects
TS . . . Technical Studies
P . Practice
* . . . Students should spend the last term of the course, for a period of not than 3 months, in the institution.
** . . . IN-PLANT TRAINING may be suitably sandwiched and the number of sessions decided in accordance with local conditions.

CHEMICAL ENGINEERING : 4 YEAR PART-TIME COURSE

Kind of subjects and total allotted hours	Subjects	Contact hours per year			
		I Year	II Year	III Year	IV year
GS 270 (15%)	English	90	..	..	..
	Humanities, Management and Administration	..	..	90	90
SAS 420 (23.3%)	Applied Mathematics	90	..	..	..
	Industrial Chemistry—I	60	..	..	..
	Industrial Chemistry —II	..	60	..	..
	Physical Chemistry	60	..	..	..
	Applied Thermodynamics	..	90	..	..
	Engineering Mechanics	60	..	..	..
TS 660 (36.7%)	Elec. Tech. & Electronics	..	60	..	..
	Hydraulic Engineering	..	60	..	..
	Heat and Mass Transfer	..	..	90	..
	Unit Chem. Engineering	..	90	..	..
	Operations & Processes—I	..	90	..	..
	-do- —II	..	..	60	..
	Elective—I	..	..	60	..
	Elective—II	..	..	..	60
	Elective—III	..	..	..	60
	Elective—IV	..	..	..	60
	Transport and Storage of Materials	..	..	60	..
P 450 (25%)	Engineering Drawing	90	..	..	..
	Design and Drawing— I	..	..	90	..
	Design and Drawing—II and Elective Lab.	..	..	..	90
	Electrical and Hydraulics Lab.	..	90	..	..
	Project work	..	..	..	90
1800 (100%)	TOTAL	450	450	450	450

GS	General Studies
SAS	Science and Applied Science Subjects
TS	Technical Studies
P	Practice

(ELECTIVES : (CHEMICAL ENGINEERING)

our elective should be chosen under any one of the diversifications

Diversification: Plastic Technology

1. Synthetic Plastics
2. Synthetic Textile Fibre
3. Moulding Techniques
4. Process Equipment Design
5. Instrumentation & Process Control

Diversification : Ceramic Technology

1. Ceramic Materials & Porcesses
2. Glass Technology
3. Refractory Technology
4. Ceramic Engg. Design
5. Instrumentation & Process Control

Diversification : Fertilizer Technology

1. Nitrogenous Fertilizers
2. Phosphatic Fertilizers
3. Synthetic Fertilizers
4. Fertilizers Plant Design
5. Instrumentation & Process Control

Some of the other diversifications which could be offered through suitable electives are:

(*i*) Nuclear Technology

(*ii*) Fuel Technology

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